THE UNIVERSITY OF ALBERTA

ESTATE PRODUCTION AND TRANSPORTATION, DOMINICA

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled Estate Production and Transportation, Dominica, submitted by David Aidan McQuillan in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

One of the characteristics of underdeveloped countries is a heavy dependence of the economy on agriculture. The difficulties in developing such an economy are imposing because of uncertain markets, lack of capital for investment and difficulties of transporting agricultural produce from the production site to the market. This problem of transportation and its influence on the location of agricultural production is the focal point of this study.

A survey, examining agricultural production on estates in Dominica and the costs of transporting this produce to Roseau, the port and market outlet, was carried out in 1967. Estates were chosen because as large units of production it was believed they would be more useful in determining the relationship between the location of agricultural production and transport costs, than the smaller peasant holdings.

An attempt was then made to determine the relationship between the variety, volume and intensity of agricultural production and variations in transport costs. It was found that no strong relationship existed between transport costs and variations in production, and it was concluded that other factors such as those of soil and climate, must also be considered in accounting for variations in agricultural production.

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INTRODUCTION

Although the problem of underdevelopment in many tropical countries has received a great deal of attention since the ending of World War II there have been few notable successes in the attempts to change conditions within those countries. Among the reasons suggested for the failure is that there remains a lack of real appreciation of the nature of underdevelopment. A symptom of this failure may be that a satisfactory explanation of the term "underdeveloped" has yet to be presented. A United Nations survey on the Measures for Economic Development of Underdeveloped Countries reported that:

> We have had some difficulty in interpreting the term underdeveloped countries. We use it to mean countries in which per capita real income is low compared with the per capita real incomes of the United States of America, Canada, Australia and Western Europe. In this case an adequate synonym would be "poor countries."[1]

By such a definition, underdeveloped countries are those with a per capita income of less than U.S. $500 per annum. Many of the former British colonies in the West Indies have per capita incomes well below this figure and could therefore be described as underdeveloped.

However, economists are well aware that a great deal more significance is attached to the term than that outlined above. Higgins remarked that "the expression underdeveloped is admittedly not a very happy one and others have been suggested such as preindustrialized and developing."[2] The use of such terms together would seem to indicate that both terms are synonymous and thus reflects a bias on the part of the individual using them. In this

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[1] B. Higgins, Economic Development, Problems, Principles and Policies, Constable and Co. Ltd., London, 1959, p. 6.

[2] Ibid., p. 7.

study, the term underdeveloped has only the broadest connotations of lack of a highly organized system of supply and demand at the economic level.

Leibenstein provides a useful list of some "characteristics of backwardness" which are found in countries often described as underdeveloped.[3] Among the economic characteristics he mentions: a high percentage (70 to 90 per cent) of the population engaged in agriculture, lack of employment opportunities outside agriculture, little local capital available for investment, poor credit facilities, poor marketing facilities and poor housing. Many of these characteristics are found in the small islands throughout the Caribbean and the most striking feature of their economies is a heavy dependence on agricultural production for export.

An economic survey of Barbados and the Windward and Leeward Islands was carried out by economists from Britain, the United States of America and Canada in 1966.[4] The aim of the survey was to assess which sectors of the economy might best be expanded to develop the economies of these islands. It was concluded that there was considerable potential for the development of a tourist industry which had not been realized, but apart from this single industry economic growth would have to take place in the agricultural sector. The Tripartite Report noted the many handicaps to industrial development. Included in these were the small size of the local market, difficulties imposed by trade barriers within the West Indian market, as well as the "lack of raw materials, skills, capital and the appropriate financial institutions and poor transport services."[5] Although the present economies are typified

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[3]H. Leibenstein, Economic Backwardness and Economic Growth, John Wiley and Sons, Inc., New York, 1960, p. 40.

[4]J.R. Sargent et al., Report of the Tripartite Economic Survey to Barbados and the Windward and Leeward Islands, H.M.S.O., London, 1967.

[5]Ibid., p. xii.

by a heavy dependence on staple crops[6] this is the area which requires least stimulation. The Report noted that "while there are real possibilities for growth for some of the existing export crops, taken as a whole these will not generate the necessary rate of growth in the economy. There is, however, considerable scope for increasing output in the rest of the agricultural sector."[7] In a few of the Windward and Leeward Islands, the population pressure on the land is not as high as elsewhere and there is a distinct possibility of developing untouched agricultural resources.

The Choice of Dominica

Of all the islands in the West Indies group Dominica has the lowest population density per square mile and the amount of cultivated land per capita is highest within the Leeward and Windward Island groups (Table I). Unlike many of the other islands there is room for expanding production of the major export crops as well as the other branches of agriculture which supply food for the domestic market.

> The economy of Dominica is more diversified than that of most of the islands and it has a wider range of development possibilities, which include improving the position of the banana industry... by developing the citrus industry and other food crops....[8]

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[6]The term staple is used here as defined by Caves and Holton. They define a staple as "a product with a large natural resource content. Some part of its fabrication must take place at the spot, even if only in the trivial sense of seizing it away from Nature. The staple is a product which does not require elaborate processing involving large quantities of labor or rare skills....which will bear transport charges and which is in international demand." R.E. Caves and R.H. Holton, The Canadian Economy, Prospect and Retrospect, Harvard University Press, Cambridge, Mass., 1961, p. 31.

[7]J.R. Sargent, op. cit., p. xi.

[8]Ibid., p. xv.

TABLE I - POPULATION DENSITY AND PER CAPITA INCOMES FOR THE BRITISH WEST INDIES

	Area in square miles	Population in thousands*	Population per square mile	Cultivated land per capita	Per capita G.D.P. in U.S.dollars
Jamaica	4411	1675	380		450
Trinidad	1980	894	449		680
Barbados	166	235	1416	.3	310
Leeward Islands:					
St. Kitts Nevis and Anguilla	150	57	380	.5	230
Antigua	170	57	334		250
Montserrat	34	13	368	.6	175
Windward Islands:					
Dominica	305	63	207	.7	215
St. Vincent	150	85	568	.3	190
St. Lucia	233	91	383	.5	190
Grenada	133	89	672	.6	200

* Figures refer to estimates of population for 1963. It should be noted that the population per square mile does not consider topography and Dominica's low population density per square mile is partly due to the large areas of empty mountain land.

Source: A.P.Thorne, "Economic Background of the B.W.I. Islands," Politics and Economics in the Caribbean, T.G. Mathews (ed), Institute of Caribbean Studies, Puerto Rico, 1966, p. 266.

Moreover, most commentators have remarked that the agricultural potential of the island which is so far untapped is quite considerable.[9] From the viewpoint of agricultural potential alone the prospect of developing the island's economy seems much brighter than in many of the other islands.

This seemingly bright prospect, however, does not reflect conditions in Dominica today. The island has long been considered one of the most backward in the British West Indies and the economy is almost entirely dependent on agricultural production for export. This dependence on export-agriculture, typical of the conditions already described by Leibenstein in underdeveloped countries, has continued for the past 150 years. Thorne remarked that "The economic structure of the [West Indian] islands explains their economic levels as fully as it evidences their origins and economic history."[10] The contribution of agriculture to the economy of Dominica is briefly described in Appendix A.

The problems facing agricultural development are many. The extremely rugged topography makes large scale mechanized production difficult and in most cases impossible. Unlike many of its neighbours, there is no land hunger in Dominica and it has already been noted that there remain large areas of agricultural potential to be developed. Moreover, one of the

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[9]"As an agricultural economy Dominica is still somewhat underpopulated with quantities of arable land still uncultivated." E. Bartell, National Income Statistics Dominica 1961-1964, University of the West Indies Institute of Social and Economic Research, Barbados, Statistical Series No. 2, p. 1; C. O'Loughlin, A Survey of Economic Potential and Capital Needs of the Leeward Islands, Windward Islands, and Barbados, H.M.S.O., Dept. of Technical Cooperation, Overseas Research Pubn. No. 5, London, 1963, p. 74; L.G. Campbell, The Development of Natural Resources in Dominica, University of the West Indies Institute of Social and Economic Research, Agricultural Series No. 3, St. Augustine, Trinidad, 1965, p. 3.

[10]A.P. Thorne, "Economic Background of the B.W.I. Islands," in Politics and Economics in the Caribbean, W.G. Thomas (ed.), Institute of Caribbean Studies, Special Study No. 3, Puerto Rico, 1966, p. 264.

characteristics of an underdeveloped area is poor transportation[11] and this problem is very much in evidence in Dominica. The problems of providing an adequate road system in Dominica are very great because of the great irregularity of the terrain, and the engineering required to overcome these difficulties is considerable.

The bulk of agricultural produce is exported through the main port of Roseau, although quantities of bananas are also shipped from a small wharf in the northern part of the island near Portsmouth. Because of the difficulties in road construction, it might be expected that the most important areas of production would be in the vicinity of Roseau. In other parts of the island further from Roseau the problems of transport would probably be greater and this might be expected to influence the scale and pattern of agriculture. Indeed, most of the small estates and peasant holdings are found in the southwestern part of the island near Roseau whereas the eastern and northeastern coastal districts are characterized by larger estates engaged in large scale production. There seemed a general relation therefore between some aspects of production and distance from Roseau, the main port and market outlet. It may well have been this observation which led Fentem to believe that: "the variety and distribution of production, as well as its volume and intensity, are largely determined by accessibility."[12] It was decided to take this statement and test its applicability to agricultural production from estates on the island. This is the focus of the study.

The Method

The information necessary for such a study was obtainable only by a survey of the estates. It was found that little basic information concerning

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[11] Leibenstein, op. cit., p. 41.

[12] A.D. Fentem, A Commercial Geography of Dominica, Indiana University, Bloomington, Indiana, 1960, p. 8.

agricultural production in Dominica was available. The agricultural census taken in 1960 has not yet been published and the Department of Agriculture in Roseau is too busily engaged in extension programmes to have much time for the compilation of data on estate agriculture. The Dominica Banana Growers' Association, however, keep accurate records of the volume of bananas exported each week from various parts of the island. This information was made available to the author and proved very useful. Unfortunately, such detailed records are not made for citrus (i.e. limes, oranges and grapefruit) and coconut production.

Because of the paucity of information it was necessary to carry out a questionnaire survey on the various aspects of estate production. The primary aim of the survey was to determine the volume of production for all crops grown on estates as well as the costs involved in transporting this produce to the port. Other questions asked in the survey related to other problems such as the source of a labour supply, the use of fertilizer and also the acreage of the estate occupied by tenants (Questionnaire Appendix B).

Some difficulty was experienced while carrying out the survey. To begin, there was no accurate record of the number and size of the landholdings on the island. There is no land tax in Dominica and so there never has been a pressing need for such a record. The survey was carried out with the use of a provisionary list of large landholdings over 50 acres in size which was supplied by the Department of Agriculture in Roseau. The list counted approximately 180 landholdings over 50 acres in size and it became evident that not all of these could be covered in the time allotted. Thus an attempt was made to examine all the landholdings over 100 acres in size, first of all, and then include as many of the smaller holdings of between

50 and 100 acres as possible. Most of the small estates occur in the southwestern part of the island and it was in this area that the largest number of small estates were omitted. The number and location of the estates examined in the survey are given in Table V and Map 7.

The main reason why the highest percentage of estates omitted in the survey occur in the southwest was due to a problem of mobility. The island's "bus" service does not originate in Roseau, but the covered trucks which serve as buses begin their journey in the villages in the morning and converge on Roseau and then return to the villages at night. There is no outgoing bus service from the capital in the morning and returning in the evening. To avoid the prohibitive costs of hired transport the author had to depend on the good nature of other travellers on the road to give him a ride. Because of this difficulty in travelling around the island the estates in the northern and eastern parts of the study area (i.e. farthest from Roseau) were examined in the early weeks of the survey and an attempt was made to interview as many of the estate managers and owners as possible in the southwest in the last three weeks. However, throughout the period of the survey the distribution of the estates examined was kept under constant scrutiny to ensure as representative a sample of the smaller estates as possible.

Estates

Some clarification of the term "estate" is necessary before further discussion. These large landholdings were once referred to as "plantations" but have since lost many of their former characteristics. It is interesting to note that although the term "plantation" was commonly used to describe large landholdings and the term "estates" used only occasionally in the early part of the nineteenth century, "plantation" was dropped in favour of "estates" after 1837. This was also the time of the emanci-

pation of the slaves and it may well be that the term "plantation" had connotations of an economy based on slavery which was undesirable after 1837. Since estates developed from plantations, they retain a few of their characteristics and may still be confused with them. It would therefore be useful to outline some of the characteristics of both.

Attention has already been drawn to the problem of defining plantations as agricultural systems.[13] Dicken's definition of a plantation as "a large commercial agricultural unit, usually with both cash and subsistence crops"[14] gives the popular impression of what a plantation is, but the definition is vague. James' definition, on the other hand, of a plantation as speculative and temporary, typified by monoculture and dependent on cheap labour,[15] is now regarded as somewhat antiquated. Gregor has noted that:

> Probably the most tenacious concepts are those which emphasize the dependence of the plantation on cheap labor, cheap land, and the inflexibility of the system in terms of monoculture and dependence on world (i.e. foreign) markets.[16]

Whatever changes have taken place in the nature of plantations as units of agricultural production the aspects of size, ownership, crops produced and labour supply are the ones which distinguish this unit from all others.

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[13]H.F. Gregor, "The Changing Plantation," Annals of the Association of American Geographers, Vol. 60, No. 2, 1965, pp. 221-238.

[14]S.N. Dicken, Economic Geography, D.C. Heath and Co., Boston, 1955, p.278.

[15]P.E. James, A Geography of Man, Third Edition, Ginn and Company, Waltham, Mass., 1966, p. 125.

[16]Gregor, op. cit., p. 225.

Plantations have long been recognized as large farms most often found in tropical areas. The actual size of a plantation has seldom been defined and similarly the size of estates has never been clearly stated other than that they are large units of land. For the purposes of the survey it was decided to regard estates as landholdings greater than 50 acres in size. This decision was taken with the full realization that some of these landholdings, including a few of over 100 acres in size, may cultivate only two or three acres of land, whereas many smaller landholdings may cultivate considerably more land than this. One of the basic factors in identifying an estate, therefore, is the actual size of the landholding without reference to the acreage of land cultivated.

Another characteristic commonly attributed to plantations was that they were usually owned by large foreign-based companies or by people not resident on the land. In Dominica a few of the large estates are indeed owned by large foreign-based companies and these estates are run as highly organized economic units. The majority of the estates, however, are smaller in size and owned by residents of the island, although not all of the owners live on the estate. In the years following the collapse of the lime industry in the 1930's a large number of the smaller estates were bought up by professional and business men who lived in Roseau. Some of those estates are not producing to their full capacity now because they are something of a secondary operation to their owners.

A problem in identifying separate estates became apparent during the survey when two estates were under the same ownership and run as a single business unit. If the two estates were contiguous then they were regarded as one and treated as one in the survey. On the other hand, if the two estates had different locations, and thus different transport costs, they

were considered as separate estates even though the owner ran them both as a single business enterprise.

Few of the estates in Dominica today could be considered as dependent on a single crop. It is true that in some parts of the island as in the Layou valley, bananas tend to be the most important crop. But on almost all estates there are several other crops of some importance. The crops grown, as in the case with those most often associated with plantations, are susceptible to changes in the world market conditions and the ravages of plant diseases and pests.

The social connotations of plantations with indentured labour living on the plantation is a rare phenomenon in the mid-twentieth century and is certainly not found in Dominica. It is true that the labour supply on a large number of estates is drawn from tenants living on the estate and who cultivate small patches of land for themselves. This may be regarded as a vestige of the old plantation system. But even these tenants are an irregular and unreliable source of labour for the estate. In the northern parts of the island the availability of labour can be a problem. On a few of the large estates, workers are drawn from the more populous southern half of the island and these workers live in specially constructed living quarters on the estate. Perhaps one reason why estate labour is scarce is because it is relatively poorly paid. Many of the workers are unwilling to work for someone else producing bananas when they could spend the time producing bananas on their own on the smallest parcels of land and receive the same income. The estate as it occurs in Dominica can hardly be described as a social phenomenon involved in the organizing of society as described by Thompson.[17]

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[17]E.T. Thompson, "The Plantation Cycle and Problems of Typology," in Caribbean Studies: A Symposium, V. Rubin (ed.), Univ. of Washington Press, Seattle, 1960, pp. 29-33.

The Aim and Scope of the Study

The aim of this study is to determine if the variety, volume and intensity of production on estates in Dominica is determined by accessibility. To do this some measure of accessibility is required. Accessibility may be measured in terms of distance. It should be remembered that Dominica is characterized by broken relief and the secondary road system is made up of narrow, steep, winding trails which present considerable difficulty for trucks. So, the farther an estate lies from a motorable or main road the less accessible it is from the port. Some estates within a few miles of Roseau which are situated at some distance from the main road are more inaccessible than other estates on the eastern coast some thirty miles from Roseau but which are situated alongside a main road.

A much more accurate indication of accessibility may be obtained from the transport costs which each estate has to pay to have the produce trucked to Roseau. On a few of the smaller estates which were not served by a secondary road, all of the produce had to be either carried out by head or pack-animal to the main road where it was then picked up by a truck and taken to Roseau. The additional cost of head carriage meant that the overall transport costs were considerably higher than if the estate had been served by a road and the produce picked up on the estate by the truck. Furthermore, it was found that the rate charged by hired truckers took into account not only distance from Roseau but the nature of the road leading to the estate. For example, if the secondary road to the estate was steep, poorly graded and pot-holed then slightly higher rates were charged by the trucker. Thus, transport costs gave some indication, not only of distance from the port,but also of the accessibility of the estate from the main roads and were found to be the best measure of accessibility.

There were several reasons for limiting the scope of the study to estate production and excluding small-holding or peasant production. Most important, it was believed that the larger landholdings would be more highly organized with regard to farm management and farming techniques, and as exclaves of a developed economy in an underdeveloped area, would probably be more susceptible to the economic influences of differences in transport costs than the smaller holdings. It was also believed that the estates would be more likely to keep accurate records of the volume of production for each year as well as reliable figures of transport costs to Roseau. So from the point of obtaining reliable information on the influence of transport costs on production it seemed that estates would give a better result.

Another factor of lesser importance in the decision to exclude small-holding production was the difficulty involved in obtaining a representative sample of these small holdings. The exact number of the numerous small landholdings is not known. Estimates were made in the Census of 1961 (Table IV), but the location of these holdings is not known and so a random sample of these units would have been well nigh impossible to obtain. The difficulty in obtaining even the crudest representative sample would have been too great in the short time available for the survey. Admittedly, some difficulty was experienced in compiling a list of estates on the island but this problem had none of the magnitude which would have been involved had small landholdings been considered.

In the study which follows, the first four chapters are preparatory for the final chapter, which analyses the relationship between estate production and transport costs. The first two chapters provide the physical setting and historical backdrop against which estate-agriculture, in its present form, has evolved. Of considerable importance to agriculture are the physical factors of relief, climate and soils. Slightly

more attention is paid to the section describing the distribution of soils because of their importance in the location of estates, e.g. in the lower sections of the main river valleys. The second chapter provides the historical background of trends in estate agriculture and the evolution of location patterns for estates. In it the influences of historical antecedents on the location of estates and patterns of production become apparent.

The third and fourth chapters represent the results of the survey carried out in Dominica in the summer of 1967. Chapter III describes the variety of estate production throughout the island as well as giving some account of the volume of production of the main crops in different parts of the study area. Chapter IV deals with variations in the cost of transporting each crop from different parts of the island to the port outlet. These chapters provide the basic information required for the analysis in the fifth chapter.

Chapter V analyses the relationship between the variety, volume and intensity of production on estates and the costs of transporting the resultant produce to Roseau. Its purpose is to determine whether these various aspects of estate agriculture are controlled by, or even significantly related to, the variations in transport costs. Finally, some conclusions are presented on the nature of the relationship between agricultural location, and transport and distance.

Measures Used

It should be noted that where reference is made to a monetary measure the unit which is used throughout the text is the British West Indian dollar (B.W.I.$) except where otherwise stated. For comparison purposes it might

be noted that at the time of the survey in 1967 the pound sterling was equivalent to B.W.I. $4.80 and the United States dollar was equal to B.W.I. $1.68. The value of the B.W.I. dollar in international markets fell with the devaluation of the British pound in November 1967. At the current rate of exchange (May 1968) the pound sterling is equal to B.W.I. $4.88 and the United States dollar is equivalent to B.W.I. $1.99. The weight measures used throughout the text refer to pounds avoirdupois and the tonnage measure refers to long tons, i.e. 2240 pounds.

CHAPTER I

THE PHYSICAL CONDITIONS

On the morning of November 3rd 1493 Columbus first sighted land, an island, on his second journey to the New World. The island (latitude 15°20' North and longitude 61°20' West) was named Dominica because it was discovered on a Sunday.

> When asked by the King of Spain for a description of it, he is said to have crushed a sheet of paper in his hand and presented it as a representation of the extreme irregularity of its surface.[1]

The physical appearance of the island is indeed very impressive, from the swift flowing streams and deep ravines to the summits which are often shrouded in mist and low cloud. With a total area of 289.5 square miles this is the third largest island of the Lesser Antilles (excluding Trinidad) and the largest of the Windward Island group (see Map 1).

There has been some speculation concerning the precise geological origin of Dominica as well as the other Windward Islands, but it is generally held that they are volcanic islands which have grown on top of a submarine ridge bordering the eastern Caribbean. The crest of this ridge now lies some 3,000 to 5,000 feet below sea level and is believed to be of tectonic origin.[2]

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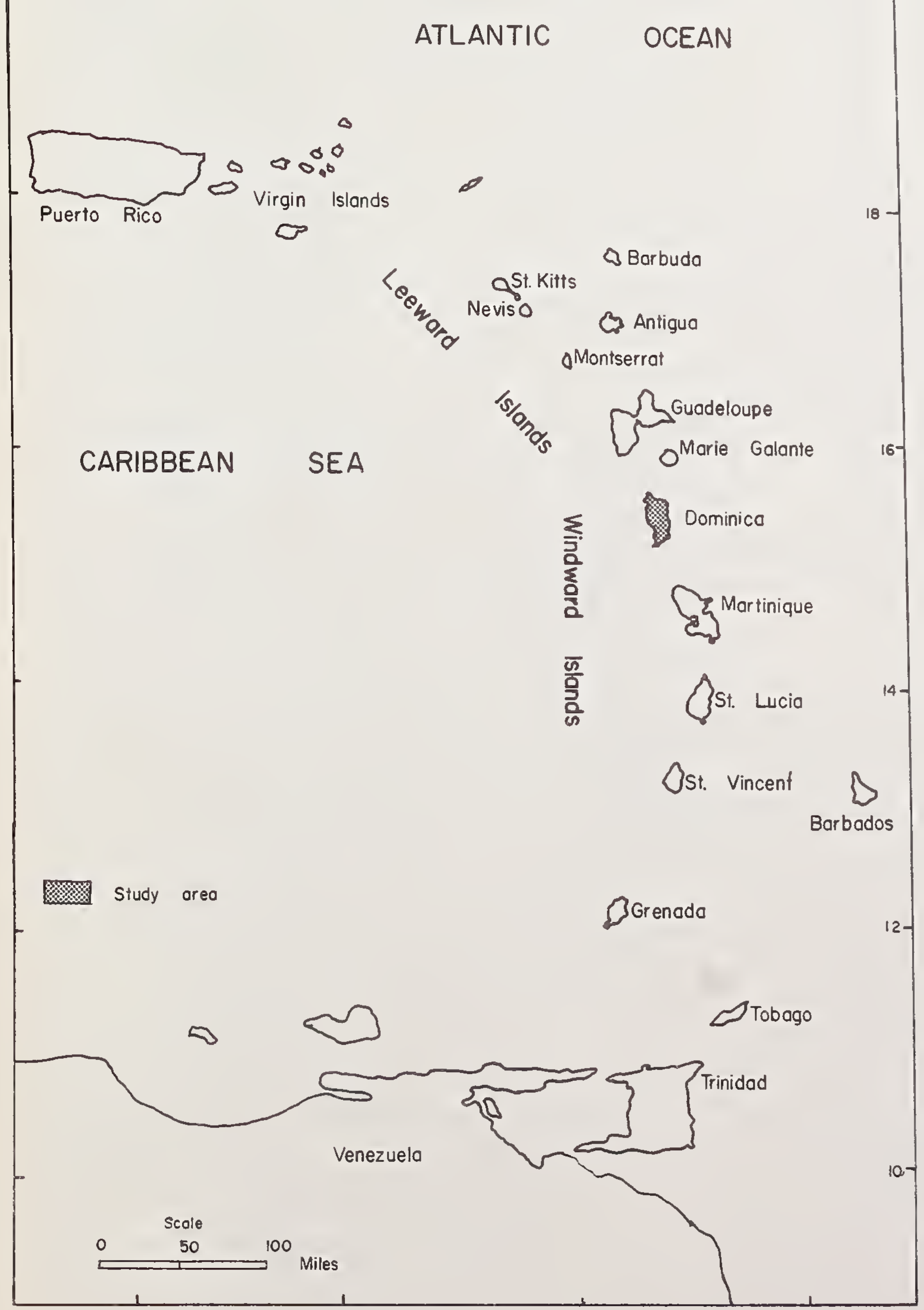
[1] J. Sturge and T. Harvey, The West Indies in 1837, London, 1838, p. 98.

[2] J.S. Beard, The Natural Vegetation of the Windward and Leeward Islands, Oxford, 1949, p. 17.


Portsmouth
Picard
Hill
Wesley
Marigot
Melville Hall
Hatton Garden
Morne Concorde 2027
Morne Diablotins 4661
Colihaut
Grand Savanna
Salisbury
Castle Bruce
Morne Laurent 2248
St. Joseph
Hillsborough
Belfast
Mahaut
Morne Trois Pitons 4450
Rosalie
Summit
4661 Height in feet
Estate
Village
Town
Fond Colet
Roseau
Copt Hall
Wall Mountain 4017
Grand Soufriere 3554
La Plaine
Belvedere
Morne Anglais 3683
Pointe Mulatre
Pointe Michel
Morne Plat Pays 2636
Geneva
Grand Bay
Soufriere
Scale
1 0 1 2 3 4
Miles
A.McQ.

ATLANTIC OCEAN
Puerto Rico
Virgin Islands
18
Barbuda
St. Kitts
Nevis
Antigua
Leeward Islands
Montserrat
Guadeloupe
Marie Galante
16
CARIBBEAN SEA
Dominica
Windward Islands
Martinique
St. Lucia
14
St. Vincent
Barbados
Study area
Grenada
12
Tobago
Trinidad
Venezuela
10
Scale
0 50 100
Miles

The volcanic activity which produced Dominica is of recent geological time compared with some of the neighbouring islands. Evidence of older volcanic activity is found in an outer island arc represented by Grand Terre, Guadeloupe, and Marie Galante nearby. These older volcanics were worn down and capped with limestone during Cenozoic times. The volcanic activity which produced Dominica did not begin until the late Miocene Period and reached their peak in Pleistocene times.[3]

The volcanoes were of the explosive type and composite cones were built up. As Hardy points out, "fragmental ejecta, such as volcanic dust, ash and stones, together with a smaller proportion of lava, make up the bulk of the island."[4] The volcanic origin of the parent rock is of some significance in understanding the nature and fertility of the soils of Dominica.

Relief

A main ridge runs north-south through the centre of the island, with peaks rising to over 3,500 feet (see Map 2). The main peaks from north to south are Morne aux Diables (2826'), Morne Diablotins (4661'), Morne Laurent (2248'), Morne Trois Pitons (4,450'), Watt Mountain (4017'), Morne Anglais (3683') and Grande Soufrière (3554'). Since early Pleistocene times weathering and erosion have greatly altered the volcanic features of Dominica. The volcanic upland has been deeply dissected by numerous short swift streams flowing into the Atlantic Ocean to the east and into the Caribbean Sea to the west. This stream dissection has produced an almost continuous series of deep narrow valleys separated by steep walled ridges.

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[3]C. Schuchert, Historical Geology of the Antillean-Caribbean Region, New York, 1935, p. 748.

[4]F. Hardy, "The Soils of Dominica, their Fertility and Genesis," West Indian Bulletin, Vol. 19, 1931, p. 90.

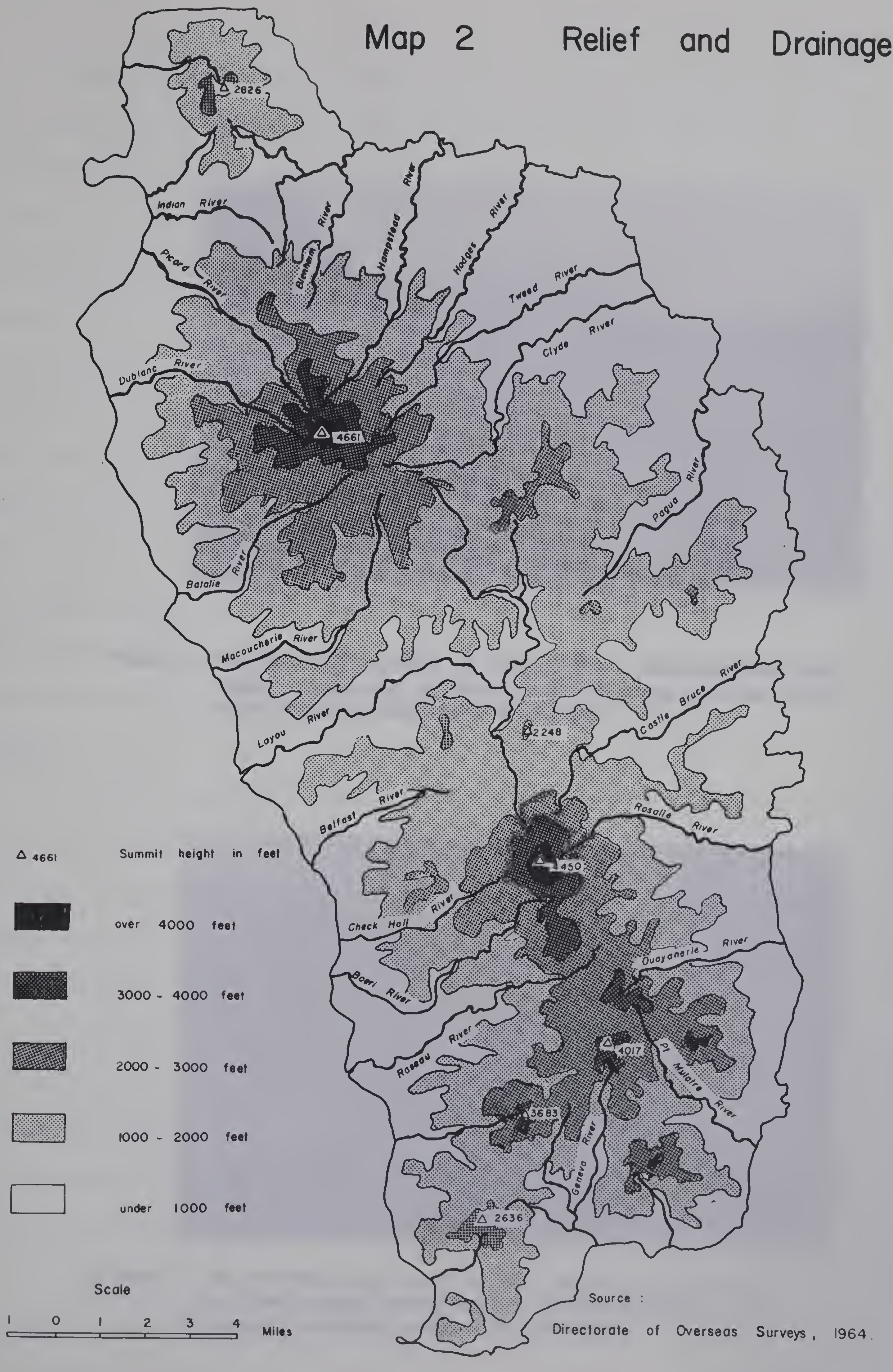
Map 2 Relief and Drainage
2826
Indian River
Picard River
Blenheim River
Hampstead River
Hodges River
Tweed River
Clyde River
Dublanc River
4661
Pagua River
Batalie River
Macoucherie River
Layou River
2248
Castle Bruce River
Belfast River
Rosalie River
4450
Check Hall River
Boeri River
Ouayanerie River
Roseau River
4017
Pt Mulatre River
3683
Geneva River
2636
Summit height in feet
over 4000 feet
3000 - 4000 feet
2000 - 3000 feet
1000 - 2000 feet
under 1000 feet
Scale
1 0 1 2 3 4
Miles
Source :
Directorate of Overseas Surveys, 1964.

Plate 1. The volcanic upland of the island's interior has been deeply dissected by short swift flowing streams which have produced deep narrow valleys.

Plate 2. The northeastern part of the island is characterized by less rugged topography. In the background the central volcanic ridge rises steeply.

Changes in sea level, due to uplift of the land, have produced terraces in a number of the larger river valleys, e.g. Morne Bruce in the Roseau valley. But these features do not indicate general uplift of the entire island and Spencer has suggested that uplift has been local, and also due to volcanic forces in recent geological times.[5] This uplift seems to have been partly responsible for increased downcutting of many streams which produced the steep walled valleys. If this theory of localized uplift is correct, then there would seem to have been little uplift in the north-eastern part of the island where, between Blenheim and Hatton Garden, a more mature landscape has developed. The existence of relatively shallow water for some distance to the north and east of this coast led Spencer to suggest that this may, in fact, be a submerged coastal plain.[6] This north-eastern corner of the island which lies below 1,000 feet, is characterized by less rugged topography and there are fewer deep valleys than are found elsewhere on the island.

Drainage

Flat land in Dominica is generally limited to the valley bottoms of the larger rivers. Some flat land is found in the larger valleys of the Pagua, Castle Bruce and Rosalie Rivers, on the eastern or leeward coast. Smaller stretches of flat land are also found in the valleys of the Wanarie, Tabarie and Point Mulatre Rivers (see Map 2).

In the north-eastern part of the island, the largest river is the Clyde, others being the Tweed, Hodges, Hampstead and Blenheim Rivers. The extent of flat land is not great, but valley slopes are less steep and interfluves are lower than elsewhere in Dominica.

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[5] J.W.W. Spencer, "The Geological and Physical Development of Dominica," Quarterly Journal of the Geological Society of London, Vol. 58, 1902, p. 351.

[6] Ibid., p. 345.

The only large river along the south coast is the Geneva River. Its valley is large and there are extensive areas of gently sloping land with a small amount of flat land along the valley bottom. A smaller stream, the Bagatelle, also has some gently sloping land but its extent is small.

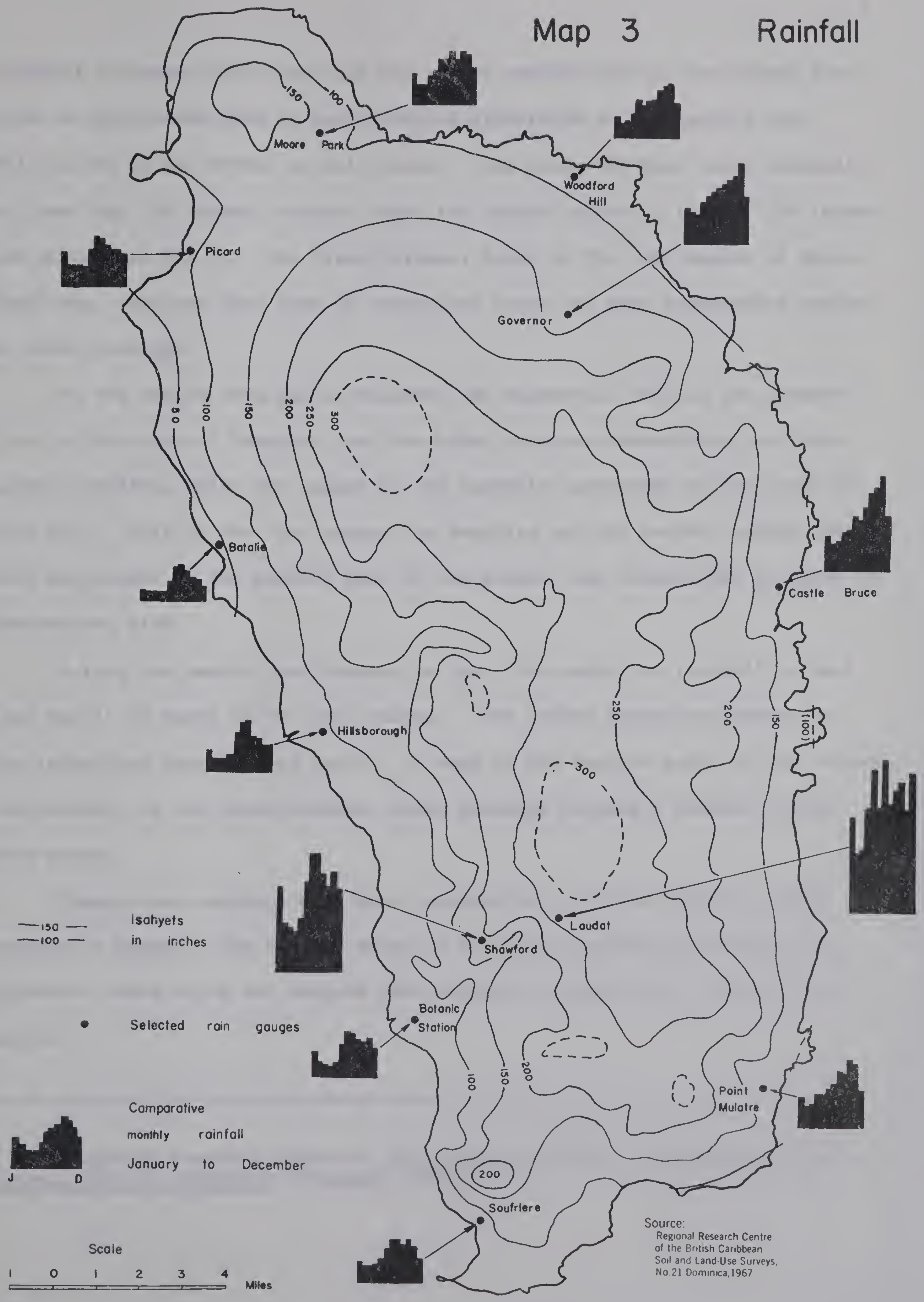
The western half of Dominica is characterized by a large number of short streams flowing in deep ravines. Small areas of flat land are found in the larger valleys of the Layou and Roseau Rivers. These are the largest rivers in the island and the Roseau River has constructed an alluvial fan on which the town of Roseau is built. Another area of flat land is found in the vicinity of Portsmouth, in the north, and smaller amounts occur in the valleys of the Picard, Macoucherie, Belfast and Boeri Rivers. On the central leeward coast, along the western flank of Morne Diablotin, is a gently sloping area known as the Grand Savanna. Along this section of coastland, river valleys are not as deep as those which lie to the south of the Layou River system. This may be attributable to the fact that total annual rainfall is lower and thus down-cutting less intensive.

Climate

Lying well within the tropics, Dominica has a climate which is characterized by heavy rainfall, high temperatures and high humidity. In making any precise statement concerning the climate of Dominica, severe limitations are imposed by the paucity and discontinuity of meteorological recordings.

A very striking feature of the climate of Dominica is the abundance of rainfall. Recordings of rainfall have been made at a large number of stations scattered throughout the island (see Map 3). These records, however, are often incomplete and vary in length from two years to fifty-six years.

Rainfall is heaviest on the higher peaks of Morne Diablotin and Morne Trois Pitons where the annual total is well over 300 inches. The amount of


Map 3
Rainfall
Moore Park
Woodford Hill
Picard
Governor
Batalie
Castle Bruce
Hillsborough
Laudat
Shawford
Botanic Station
Point Mulatre
Soufriere
150
100
50
200
250
300
Isohyets in inches
Selected rain gauges
Comparative monthly rainfall January to December
J
D
Scale
1 0 1 2 3 4
Miles
Source:
Regional Research Centre of the British Caribbean Soil and Land-Use Surveys, No.21 Dominica, 1967

rainfall increases with elevation but on the western side of the island less rain is experienced than at corresponding elevations on the eastern side. This is due to the effect of rain shadow. All along the west coast rainfall is less than 100 inches, whereas along the eastern coast it is over 100 inches per annum (see Map 3). The Grand Savanna, lying in the rain shadow of Morne Diablotin, receives less than 50 inches per annum and even experiences periods of water shortage.

In the months from May to December the equatorial belt of low pressure lies to the south of Dominica, and the island receives convectional and orographic rainfall which are common in the unstable airstreams to the north of this belt. This is the "wet season" in Dominica and the wettest months are July and August on the western side of the island, and October and November on the eastern side.

During the months from January to April the amount of rainfall is much less and it is known as the "dry season." The driest months everywhere on the island are February and March. In some of the western parts of the island, particularly in the Grand Savanna, water shortage becomes a problem during this season.

Temperature readings have been recorded only for the Botanic Gardens station in Roseau. The monthly means of the daily maximum and minimum temperatures shown below are derived from figures recorded over a seventeen-year period.[7]

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[7] Regional Research Centre of the British Caribbean, Soil and Land Use Surveys, No. 21, Dominica, Trinidad, 1967, p. 8.

	J	F	M	A	M	J	J	A	S	O	N	D
Minimum	68	67	68	69	71	73	72	73	73	72	71	69
Maximum	84	85	87	88	90	90	89	89	90	89	87	86

Further inland, temperatures decrease with elevation and Hodge suggests that the drop in temperature may be as much as 10°F for an elevation of 1,800 feet above sea level.[8] With the temperature recordings from the Botanic Gardens station, and using the saturated adiabatic lapse rate, the Regional Research Centre of the British Caribbean has constructed a map showing the approximate mean annual temperatures, based on elevations above Roseau (see Map 4).

No recordings have been kept of humidity, winds or duration of sunshine in Dominica. However, it might be expected that the humidity pattern for Dominica would closely correspond to those in Guadeloupe immediately to the north and Martinique to the south. The observations made in Guadeloupe and Martinique "indicate maxima and minima of about 90 per cent and 70 per cent with little seasonal variation at sea level in open exposures."[10] The predominant winds in Dominica are the north-east trade winds. During the wet season these winds become easterlies for a period. Winds are strongest along the eastern coast and much of the vegetation in this part of the island has the appearance of having been sculptured by the wind. Occasionally, hurricanes and wind storms, originating in the Atlantic to the south-east of Dominica, brush past the island on their trek northwards. The associated strong winds are a hazard to all tree crops, particularly to bananas. This hurricane season usually lasts

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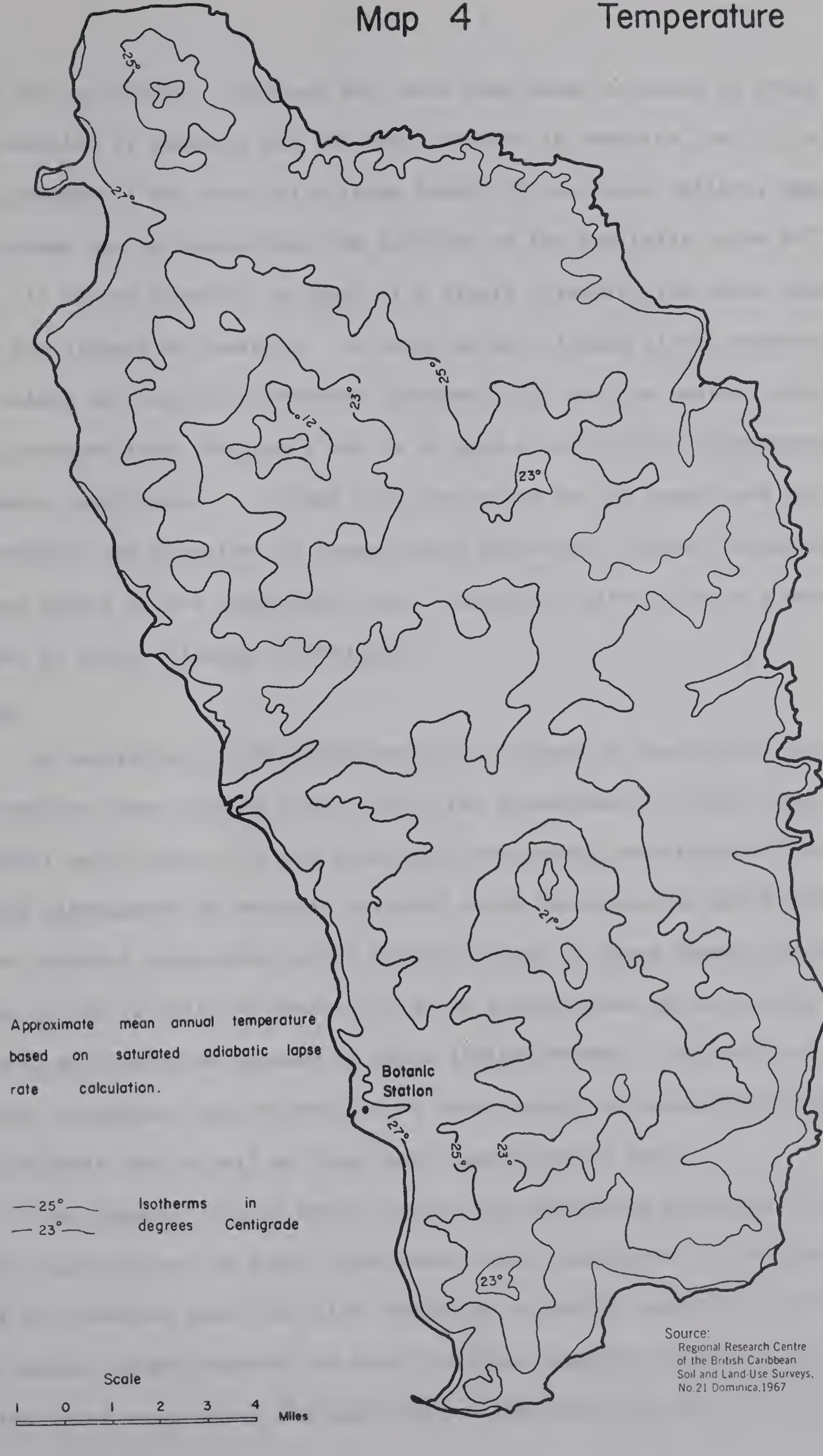
[8] W.H. Hodge, "The Vegetation of Dominica," Geogr. Review, Vol. 33, 1943, p.354.

[9] Regional Research Centre of the British Caribbean, op.cit., p. 5.

[10] Ibid., p. 4.

Map 4 Temperature



from July to October, although they have been known to occur in other months. The duration of sunshine has not been recorded in Dominica, but it is noted that because of the depth of a large number of the river valleys, many of the slopes are in shadow when the altitude of the sun falls below 40°.

It is not possible to speak of a single climatic type which characterizes the climate of Dominica. To refer to the climate of the eastern side of the island as tropical rainforest (Koeppen's Af) and the western side as tropical monsoon type (Koeppen's Am) is to give a very limited impression of the climatic conditions. These wide variations in the amount and distribution of rainfall and sunshine, of temperatures and winds, further increased by the broken nature of the topography, have, therefore, given rise to a very large number of local climates in Dominica.

Soils

In describing the distribution of soil types in Dominica it is useful to consider those factors which affect the development of soils, viz. parent material and climate. In the study area the parent materials are the fragmented ejectamenta of volcanic extruded rocks forming tuffs and breccias. A few isolated calcareous marine deposits found at Morne Daniel and Morne Bruce in the vicinity of Roseau are of no significance in accounting for the general soil patterns because of their limited extent. The soils of the island, therefore, are derived from a wide variety of volcanic pyroclasts and volcanic ash as well as from small quantities of lava.

The climatic factors which control the weathering processes of this parent material are of great importance. Great variations in the type of soil are produced under the wide variety of climatic conditions found on the island. Where rainfall is high, leaching continues uninterrupted, but in the drier areas along the west coast which have less than 80 inches of

rain per annum and several dry months, then chemical weathering may be interrupted due to lack of continuous moisture supply. The high temperatures of the island are also an important element in the soil forming processes.

The distribution of soils is also affected by the diversity of the topography and the nature of the slopes. The angle and aspect of the slope will influence the degree of insolation, water runoff, vegetation cover and the stability of the soil masses. Seldom do mature soils develop on the steeper slopes. Thus, as in the case of climatic patterns, the variations in soil patterns are greatly influenced by the complexity of the topography. Because of the diversity of these factors influencing soil formation, there is diversity in the distribution of soils. Over large parts of the island there is a juxtaposition of soil types (red earth, brown earth and lithosol), none of which is so extensive that it is significantly more widespread than the others (Map 5).

Much of the pioneering work in the classification of the volcanic soils of Dominica and other islands in the Lesser Antilles was carried out by F. Hardy.[11] His classification (see Appendix C) is used as a basis for the description of the soils of Dominica.

On the uppermost slopes of Morne Diablotin, Morne Trois Piton and Morne Micotrin, poorly developed lithosol soils are found. These soils are also found juxtaposed with the "brown earth" and "red earth" soils in the northern and eastern half of the island. These young soils tend to be gravelly or sandy, have little moisture retention capacity and are of no agricultural value. Alluvial soils are found in the larger river valleys where there is

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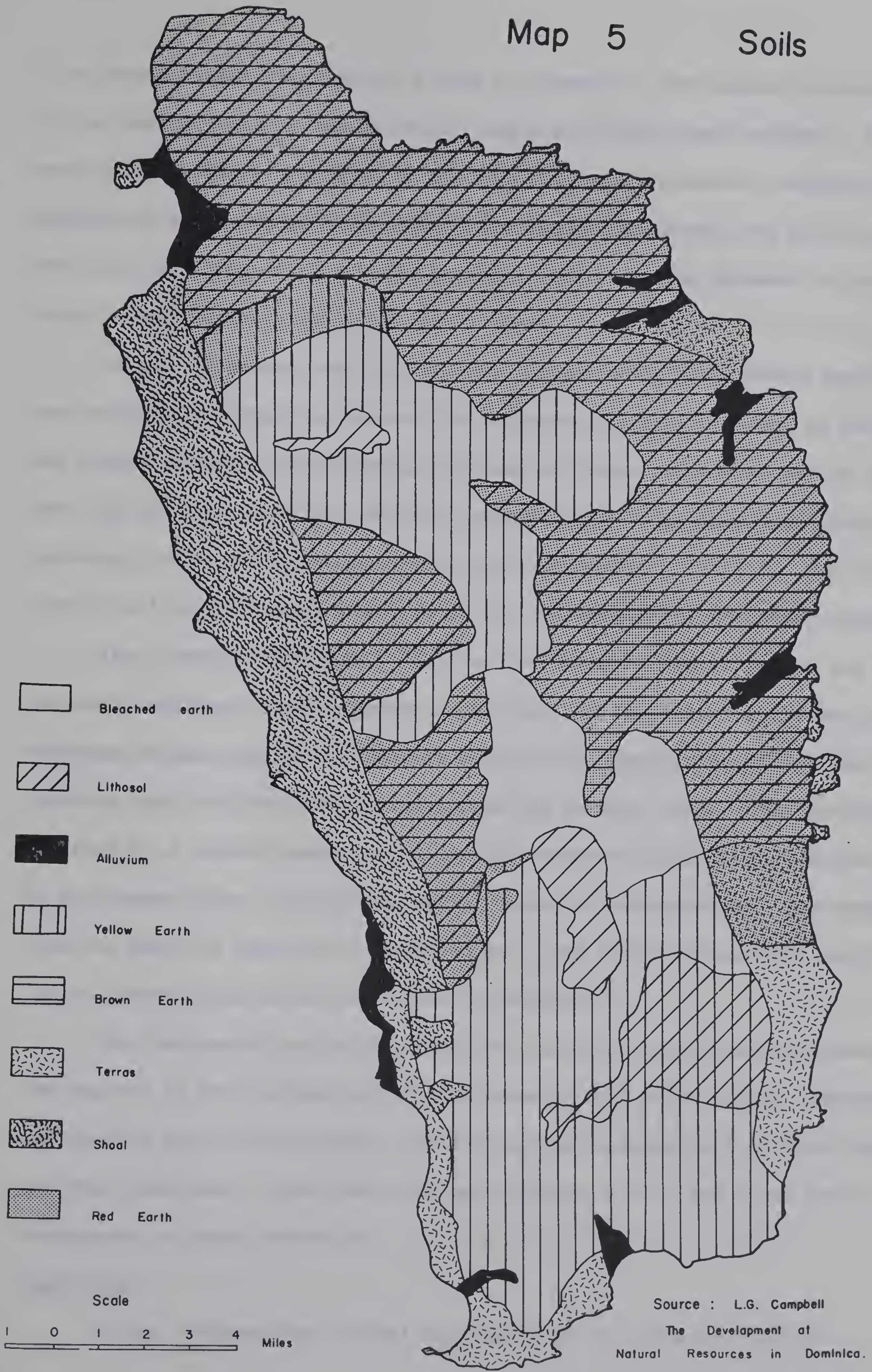
[11] Hardy, op. cit.

F. Hardy and G. Rodrigues, "Soil Genesis from Fragmental Volcanic Rocks in the Lesser Antilles," Proceedings of the Soil Science Society of America, Vol. VI, 1941, pp. 47-51; F. Hardy and J.S. Beard, Soil Formation in the British Caribbean Volcanic Islands (P.R. Soil Conference), 1950. (mimeo.)


Map 5 Soils
Bleached earth
Lithosol
Alluvium
Yellow Earth
Brown Earth
Terras
Shoal
Red Earth
Scale
1 0 1 2 3 4 Miles
Source : L.G. Campbell
The Development of
Natural Resources in Dominica.

flat land on which the deposited silt will remain. The largest deposits are in the Roseau, Geneva, Castle Bruce, Pagua and Clyde River valleys. A large area of alluvium is also found in the vicinity of Portsmouth. Because of the absence of slope, these soils often have impeded drainage, and in an area to the north of Portsmouth, a swamp has been created. The lithosol and alluvial soils belong to Hardy's "Azonal soil" class.

Of the Intrazonal soil group, the "yellow earth" and "brown earth" soils are found on the wetter slopes of the eastern side of the island as well as on the higher slopes of the uplands. Because of their youthful stage of development and the fact that many mineral components have not been lost through leaching, these soils are generally regarded as highly fertile. The "brown earth" soil is the less attractive of the two because of its stony nature.

The "terras" and "shoal" soils of the western coastal region are more maturely developed than the "brown earth" and "yellow earth" soils and impeded drainage becomes apparent. Because many of the minerals have been lost through leaching they are also less fertile than the younger soils. The "terras" soil is found in a narrow coastal strip in the southwest stretching from the Boeri to the Geneva River. The "shoal soils" occur in a broader belt northwards from the Boeri as far as the Picard River. The other hydromorphic soil group, "terre grasse" soil is not important in Dominica.

The "red earth" soils represent the Zonal Soil group and are found in the regions of the "yellow earth" and "brown earth" soils in the northern and eastern half of the island. This is a well matured soil, highly leached and well compacted. Water does not pass through freely and these soils are recognised as being infertile.

Vegetation

In his study on the natural vegetation of the Leeward Islands,

Beard[12] noted that six climax vegetation communities could be recognized and he classified them according to environmental conditions. He also pointed out that "the great majority of the climax formations of the Lesser Antilles are climatic, predominantly determined by the influences of climate rather than by those of soil or site."[13] The only exception to this in Dominica is the "swamp forest" which is determined by edaphic conditions. The six climax communities are rainforest, lower-montane rainforest, montane thicket, elfin woodland, littoral woodland, and swamp forest. The more extensive vegetation types are to be found in the secondary vegetation groupings than in the primary vegetation groupings. Secondary vegetation appears when land which has been cleared of the original vegetation cover is allowed to revert to its natural state. It includes palm brake, secondary rainforest, dry scrub-woodlands, savanna and grazing lands (see Map 6).

The rainforest vegetation is to be found in a large section of the interior highlands, particularly on the Yellow-Earth soils to the east and south of Morne Diablotins, as well as on some intermediate slopes of Morne Trois Pitons. The lower montane rainforest occurs in the eastern parts of the island, particularly in the Pagua and Castle Bruce River valleys. The dominant trees of these rainforests seldom reach a height greater than 80 feet and a thick vegetation canopy is formed in the tree tops. There is little other vegetation near the forest floor. The distribution of these vegetation types is associated with the areas having more than 120 inches of rainfall per annum, except for the higher exposed slopes of Morne Diablotins, Morne Concorde and Morne Trois Pitons.

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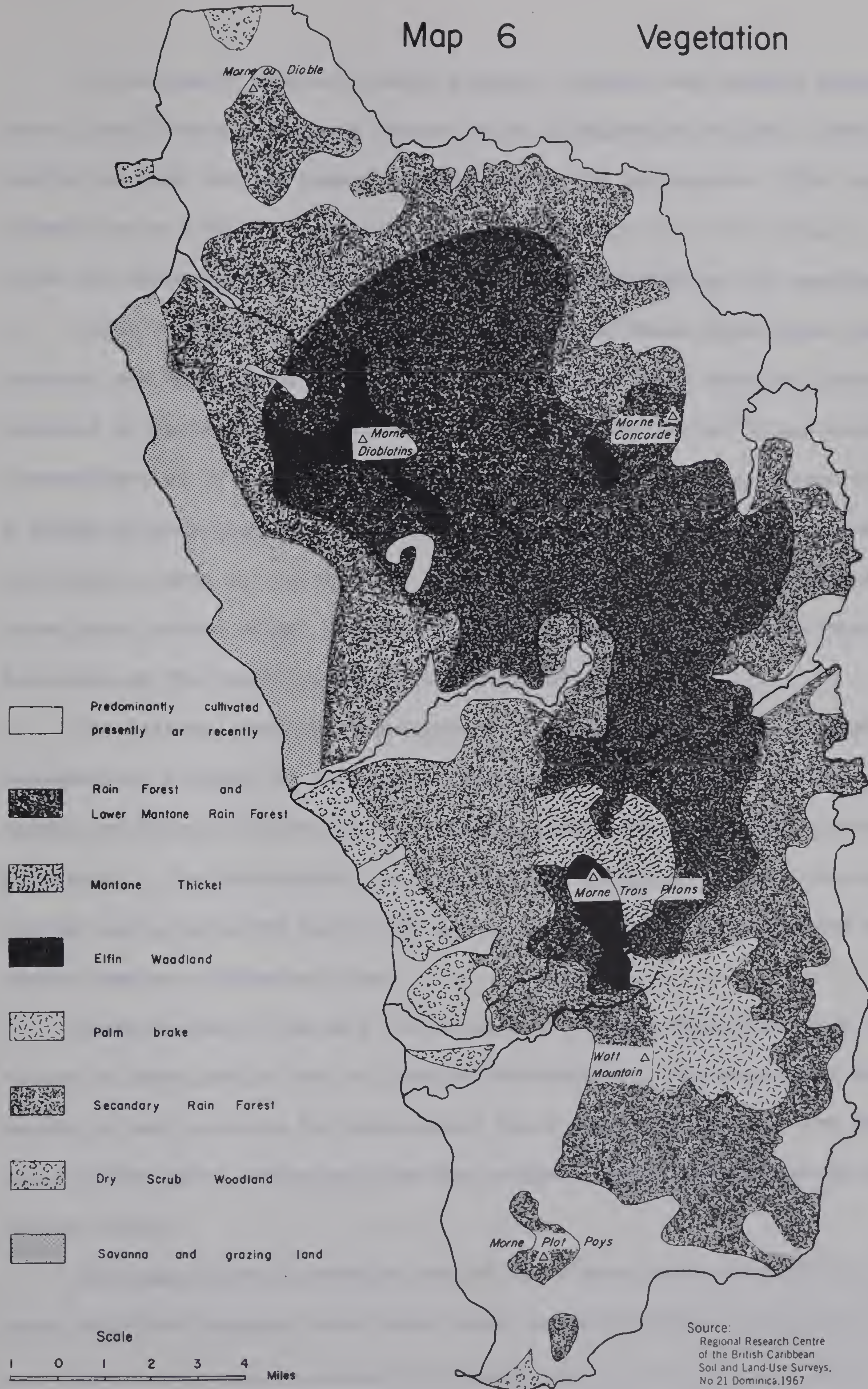
[12] Beard, op. cit.

[13] Ibid., p. 53.



Map 6 Vegetation
Morne au Dioble
Morne Dioblotins
Morne Concorde
Morne Trois Pitons
Watt Mountain
Morne Plat Pays
Predominantly cultivated presently or recently
Rain Forest and Lower Montane Rain Forest
Montane Thicket
Elfin Woodland
Palm brake
Secondary Rain Forest
Dry Scrub Woodland
Savanna and grazing land
Scale
1 0 1 2 3 4
Miles
Source:
Regional Research Centre of the British Caribbean Soil and Land-Use Surveys, No 21 Dominica.1967

On the poorly drained, gently sloping, northern and eastern slopes of Morne Trois Pitons, a montane thicket type of vegetation occurs. Trees are neither so high nor the canopy so dense as in the rainforests. The larger trees rise to a height of 60 feet and light penetrates to the ground. The trees are often covered with moss, and lianas and epiphytes are numerous.

Elfin woodland grows on the higher slopes of Morne Diablotins, Morne Concorde and Morne Trois Pitons. These slopes have well over 300 inches of rainfall per annum (and Hodge even suggests over 400 inches[14]) and reduced temperatures of 60°F to 65°F. The trees are low and gnarled, seldom reaching a height greater than 20 feet on the highest slopes. The trees are festooned with mats of moss and epiphytes. The atmosphere is humid and condensation takes place on the twigs, branches and moss. This elfin woodland vegetation has grown on the poorly developed lithosol soils.

The littoral woodland vegetation is best described as a low hedge which increases to a height of 60 feet farther inland. This "hedge" is thick and matted and, being subjected to the persistent Atlantic winds, has a wind-shorn appearance. The distribution of this vegetation type is limited to a narrow coastal strip along the east coast and is not sufficiently widespread to appear even on a large-scale map.

Swamp forest is the only edaphically determined vegetation type mentioned by Beard and is also of limited distribution. The vegetation consists mostly of tall fern and buttress-rooted trees which are found in the swampy soils of the river estuaries along the northern coast from Portsmouth to Hatton Garden.

Although Dominica contains more of the climax vegetation than most other Antillean islands, very large areas are now covered in vegetation which

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[14]Hodge, op. cit., p. 373.

can be described as secondary. Palm brake is found on the higher slopes which are steep and subject to landslides. It is not found in pure stands, but is intermixed with montane thicket and is associated with the lithosol soils on the eastern flank of Watt Mountain.

The occurrence of secondary rainforest is much more widespread than any other type of vegetation and results from the disturbance of the original vegetation by attempts at crop cultivation. Agricultural clearings, which have fallen into disuse, quickly revert to secondary bush and the trees usually grow to a height of 30 feet. A large number of lower level vegetation types such as small trees, shrubs and grasses, are also found in association with the secondary rainforest.

On the western side of Dominica where annual rainfall may fall below 80 inches there is a broad belt of vegetation classed as xerophytic. In the Cabrits region to the north of Portsmouth, in a belt between the Layou and Roseau Rivers, and on the extreme south-western coast, patches of dry scrub woodlands are found. The tallest trees grow to a height of 60 feet and there is a lower stratum of smaller trees and shrubs. The February-June dry season is responsible for the distinctive character of this vegetation type. During this period leaves wither and fall from the trees and by the end of May the woodland looks tinder dry.

During the nineteenth century, when the original vegetation cover was removed, the shoal soils of the western coast supported coffee plantations and other forms of agriculture. Large stretches of this land are no longer cultivated and in the driest areas a secondary vegetation has appeared. Beard gives the name "fire grassland" to this vegetation type which is referred to as "savanna and grazing land" on Map 6. The vegetation is

similar to the dry scrub woodland except that there are fewer trees and grasses, and shrubs predominate. Within the belt of savanna and grazing land, lying between the Macoucherie and Batali Rivers, is an area known as the Grand Savanna. It is a gently sloping platform which may have been formed by the most recent lava flow in Dominica. Soils are shallow and poorly developed while the vegetation cover of grasses and shrubs look withered and dry, even in the rainy months of July and August. The area is used mainly for grazing, and most of the small amounts of sugar cane grown on the island are found here.

The purpose of this review has been to explain the physical conditions which affect estate production in Dominica. The aim has been to set the scene for a discussion of differences in agricultural production on estates throughout the island today. Before this discussion is attempted, however, it would be useful to examine the historical evolution of agriculture and discover how it has influenced present patterns of agricultural production.

CHAPTER II

THE DEVELOPMENT OF AGRICULTURE

A brief discussion of the economic development of Dominica would facilitate a more complete understanding of the present state of agriculture; problems of marketing agricultural produce as well as present patterns of production. In the first part of this chapter the history of Dominica's agricultural economy will be traced in order to show how dependence on a single crop economy has led to cycles of economic prosperity and collapse, and so clarify the problems which face agriculture on the island today. The second part of this historical survey will try to discover the evolution of estate agriculture in different parts of the island and help to explain the present patterns of production.

The European colonization and economic exploitation of Dominica came later than that for most of the other West Indian islands. Although the island was discovered by the Spanish, it was the French and British who showed an interest in its colonization - an interest which was savagely rebuffed for many years by the native Carib people. The hostility of the natives discouraged all colonizing attempts until the middle of the eighteenth century. By that time the first agricultural settlements were being established and Atwood wrote in 1791 that "The land of Dominica is quite new, very little of it having been more than thirty years under cultivation, and a great part of it, it is probable, never since the creation."[1]

The eighteenth century was a period of internal social, economic and

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[1] T. Atwood, <u>A History of the Island of Dominica</u>, London, J. Johnson, 1791, p. 80.

political unrest for Dominica. Plantation life was hazardous with the numerous raids of the Caribs and in the later decades of the century the raids of runaway Negro slaves. The jurisdiction over the island passed from the British to the French and back again with each outbreak of hostilities between the two powers. These interruptions created serious problems for the economic development and export trade of the island. Most of the export trade was with Britain, even during the French occupation and war, and the fluctuations of prices on the London markets as well as changes in the import duties imposed on Dominican produce, had very marked repercussions on the economic activity of the territory.

The impact of the French in Dominica, through early settlement and later military occupation, was more impressive in the economic development of the island than that of the British during the second half of the eighteenth century. British rule was established with the Peace of Paris in 1763 but with the beginning of the American Revolution the island was taken by a French force under the Marquis de Bouille in 1778. He appointed the Marquis Duchilleau as military commander to govern the island for most of the following five years of French occupation. During these years France showed no interest in developing trading relations with Dominica and the export trade was seriously cramped. All produce, which was sent to Britain, had to pass through neutral ports and the export duties demanded by the French were a serious impediment to development. Moreover, the harassment of the English planters by the French forced some of them to give up and leave the island. Peace was restored by the Treaty of Versailles (1783) which returned Dominica to the British. Although several attempts were made by the French to recapture the island in 1795 and 1805, it has remained under British jurisdiction since 1783.

The agricultural development of the island was begun by the early French settlers who produced coffee and a few other crops. British settlement really began in 1765 when allotments of land (not more than 100 acres of cleared land

and not exceeding 300 acres of wooded land) were sold by the British to new settlers. These new settlers joined the French in the production of coffee but they also introduced the cultivation of sugar which was widespread in the other British West Indian possessions. Among other crops produced in smaller quantities on estates were bananas, cocoa and indigo, and the Negroes planted tobacco in their gardens for their own use. Atwood noted that the cultivation of cotton and ginger was totally neglected.[2] The two most important crops, however, were sugar and coffee; the former grown mostly by the English and the latter almost exclusively by the French.

The Coffee Period

In 1819, Edwards commented in his history of the British West Indies, that "the French inhabitants of Dominica are still more numerous than the English, and possess the most valuable coffee plantations in the island, the produce of which has hitherto been found its most important staple."[3] Much of the coffee was grown on the slopes along the coast or on the valley sides near Roseau. At the turn of the century there were more than two hundred coffee plantations in Dominica and the French planters sold their produce to English merchants who exported it to Europe.[4]

A number of reasons might be suggested which would help explain the predominance of coffee during these last decades of the eighteenth century and the first twenty years of the nineteenth century. It seems that the holdings

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[2]Ibid., pp. 82-87.

[3]B. Edwards, The History, Civil and Commercial, of the British West Indies, London, G. and W.B. Whittaker, 1819, pp. 432-433.

[4]Atwood, op. cit., p. 81.

of the French planters were small, too small in fact to make sugar production economical.[5] Moreover, the difficulties experienced by the sugar industry during the French occupation meant that coffee was never seriously challenged by its rival, sugar, as the most important export commodity. Coffee was king through default.

A positive stimulus to coffee production was not given until the early nineteenth century. "Coffee production was long checked by the excessive charges which it was forced to bear upon entrance into the British market. These were purposely set high lest an extensive introduction of the berries reduce tea consumption."[6] However, the import duties on coffee were successively reduced from 1s. 7 7/8 d. per lb. in 1806 to 6d. per lb. in 1825 and these relaxations provided real stimulus to coffee producers. Thus the favourable treatment of the French planters during the French occupation in the late eighteenth century and the stimulation of coffee production by the lowering of tariffs in the early nineteenth century account for the supremacy of coffee as an export commodity.

This supremacy continued until the late 1820s when two events appeared almost simultaneously which had immediate consequences for the coffee industry. In 1829 a blight appeared on the coffee trees and lasted for four years. No remedy was known and the coffee plantings were severely damaged.

> About the same time the blight appeared, the price of sugar was soaring, and the raising of sugar cane was becoming the most alluring commercial undertaking. Many a planter preferred to root out his coffee trees, rather than to endeavor to combat the insect pest, and to plant sugar

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[5]Bryan Edwards Press, The Old Plantation System in the British Caribbean, n.d., p. 28.

[6]*Ibid.*, p. 31.

> cane, and did so even in areas where natural environmental conditions were unsuited for its cultivation.[7]

The transformation of coffee plantings to sugar estates took place during the 1830s and the export of coffee continued to fall rapidly from 371,760 pounds in 1840 to 10,990 pounds in 1875.

The Sugar Industry

The early growth of the sugar industry from the time of its introduction by the first English settlers in the 1760s can only be described as spasmodic. Sugar growing was not an instant success due to the fact that many of the first planters were not acquainted with the techniques and requirements of sugar cultivation. Sugar was planted in some interior parts of the island where environmental conditions were unfavourable and the capital invested was soon lost. The industry received some stimulation with the creation of Roseau as a free port in 1776. After this time all imports from the colony were required to pay the customary import duties for all foreign goods entering the British market "excepting muscovado and rum certified to be of local origin."[8] This exception of sugar products from import duties was not extended to other Dominican products and so the production of sugar was made more attractive to the growers.

Twelve years later, however, the occupation of the territory by French forces during the American Revolution had serious consequences for the newly established sugar industry. The French commander, the Marquis Duchilleau, harassed the English planters during his stay on the island because of his continual fear of a resurgence on the part of the planters to recapture the island for Britain. He offered no protection to these planters from the raids of runaway Negro slaves and in fact encouraged such raids, seeing them

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[7]L.C. Harrison, "A Wet Tropical Human Habitat," Economic Geography, Vol. 11, 1935, p. 68.

[8]Bryan Edwards Press, op. cit., p. 30.

as a further measure of repressing any British resistance. The Marquis also made inordinate demands for the supply of cattle from the English plantations for meat for the military hospital. During the five years over 60 per cent of the island's cattle were slaughtered and thus the sugar estates were deprived of their power resource for the sugar mills. During this period over 30 sugar estates collapsed and by the turn of the century there were only 50 sugar producing estates left.

The export of sugar was further impeded during the French occupation. As with all other produce, it was exported through the neutral Dutch island of St. Eustatius until hostilities broke out between the Dutch and British, after which exports passed through the neutral European port of Ostend. At this time there was a decline in sugar prices which weakened the position of the industry. Moreover, the cost "of shipping it off from the out-bays to Roseau was then nearly double what it is now [wrote Atwood in 1791]; and the duties paid to the French Custom-house for exporting the sugar alone was upwards on twenty per cent.on their estimation of its value."[9] The decline in sugar prices combined with an increase in export costs and duties, and the hardship experienced by so many of the early sugar producers during the French occupation, account for the early weakness of the sugar industry.

The increase in sugar prices during the 1830s on the British market and the ruin of coffee plantings due to blight resulted in the replacement of coffee with sugar on a large number of estates. Several estates such as Rosalie and Hillsborough (Map 1) had been producing sugar since the late eighteenth century, but the number of estates which were switching to sugar growing was noticed by visitors to the island. During a visit to the Roseau

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[9]Atwood, op. cit., p. 157.

valley in 1825, H.N. Coleridge described the slopes of the valley as "clothed up to their cloudy canopies with rich parterres of green coffee, which perfumes the whole atmosphere...."[10] Fifteen years later J.J. Gurney described the same valley and the changeover to sugar production. There was a sugar plantation and sugar works at Copt Hall and the estate at Wotten Waven was being transformed into a sugar estate.[11] J. Stürge and T. Harvey mention the large sugar works at Geneva Estate and the sugar growing on other neighbouring estates. Having crossed the crest of the ridge which separates Grand Bay and Soufrière Bay they looked down on Soufrière Estate and remarked that it "like the two preceding [estates] was a coffee plantation in a stage of transition to a sugar estate."[12]

Despite the boost given to the sugar industry by the rise in sugar prices, conditions were far from favourable for the development of this industry as the basis of the economy and export trade. Although the emancipation of slaves in 1834 meant that sugar produced by the slave economies of Brazil and the Spanish Indies was cheaper than that of the emancipated British islands, nevertheless the "British producers were assisted by a discriminating tariff levied against slave-grown sugar. In 1846 this differential duty was lowered and then abolished. Costs of production in the British Colonies had doubled after the abolition of slavery and, in the absence of a protective [tariff], the position became precarious."[13] The industry limped through these diffi-

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[10]H.N. Coleridge, Six Months in the West Indies, 1825, London, Ward, Lock and Co., 1832, p. 137.

[11]J.J. Gurney, Familiar Letters to Henry Clay of Kentucky, describing a winter in the West Indies, New York, Mahlon Day and Co., 1840, p. 62.

[12]J. Sturge and J. Harvey, The West Indies in 1837, London, Hamilton, Adams, 1838, p. 96.

[13]C.Y. Shephard, "The Sugar Industry of the British West Indies and British Guiana with special reference to Trinidad," Economic Geography, Vol. 5, 1929, p.149.

culties but with interruptions in the shipping of sugar to Europe during the American Civil War the problems of the sugar producers were further accentuated. During the 1870s, competition from European grown beet sugar and a decline in sugar prices from 25 shillings per hundredweight in 1870 to 9 shillings per hundredweight in 1897 dealt a mortal blow to an industry which had never been particularly vigorous.

The Cocoa Interlude

The decline of the sugar industry had been gradual over much of the second half of the nineteenth century and estate owners began looking around for other crops as a substitute for sugar. The very lowering of tariffs in 1846 which marked the beginning of the end for the sugar industry was the first stimulus to the growing of cocoa for export in Dominica. As duties were lowered the market prices of cocoa rose and many planters turned to producing this crop, despite the high risk of damage from strong winds. With the gradual demise of sugar, cocoa emerged as the leading export commodity which would sustain the colony during the depression of the 1890s.

Cocoa exports rose from almost 16,000 pounds in 1846 to over 680,000 pounds in 1895. "Both [cocoa and limes] began to be planted on a large scale during the eighties, were slowed in their growth by a series of storms during the deep depression of the nineties, and emerged dominant by 1900."[14] The peak production for cocoa of two million pounds was reached in 1905 but by that time lime production was attracting capital away from cocoa. Thus, the exports of cocoa began to decline and with increasing competition from West African producers, and severe damage from hurricanes in 1915 and 1916, the fate of the cocoa industry was sealed.

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[14]A.D. Fentem, "The Historical Geography of a Tropical Economy - Dominica, T.W.I.," Bulletin of the Illinois Geographical Society, Vol. 2, 1960, p. 9.

The Lime Industry

The growing of limes on a large scale for export appeared, along with cocoa cultivation, as an alternative to sugar production in the late nineteenth century. This was made possible by the establishment of a foreign market for lime juice as well as fresh limes. L. Rose, a Scottish businessman and founder of the Rose Lime Juice Company, obtained a royal patent for bottling lime juice to be sold on the domestic market in Britain. The patent was granted in 1867 and a monopoly was procured. To supply this industry Rose established lime estates in Dominica as well as in West Africa. The planting of limes on estates increased during the last two decades of the nineteenth century and by the turn of the century lime exports were challenging those of cocoa as the most important export commodity.

The rapid growth of the lime industry is succinctly described in the articles by Harrison and Fentem. Harrison pointed out that "limes and cacao were rival crops in Dominica at the beginning of the present century. Prosperity reigned in the island; there was a marked influx of English with moderate capital; roads were constructed and lands in the interior sold."[15] The opening of a factory in Roseau about 1905 for the crushing of limes and extraction of citrate had a significant effect in stimulating lime cultivation.

> It was almost inevitable that the lime industry should gain the ascendancy over cacao, because the later [sic] can be grown only in sheltered locations at low elevations, and there is a dearth of such land in Dominica. Limes were hardier, would grow on various soils and at elevations up to 1500 feet. In time they came to be concentrated on the lee coast north and south of Roseau.[16]

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[15] Harrison, op. cit., p. 72.

[16] Fentem, op. cit., p. 11.

They were also planted in the northeastern part of the island where Rowntree and Co. had several estates which were found unsuitable for cocoa cultivation and were planted in limes instead.

The boom in the lime industry continued until the second decade of this century. Lime juice was exported to Britain for the beverage industry and fresh limes were sold in the United States for use in cocktails. Again the economy of the island was dependent on the success of a single crop and there was some apprehension concerning the future of the lime industry when the export of fresh limes to the United States fell from 45,000 barrels in 1914 to 19,000 barrels in 1920. Despite these fears little was done to diversify the economy and the lime exports in 1922 accounted for 90 per cent of total exports. A further decline in the demand for fresh limes came with the introduction of "Prohibition" in the United States during the 1920s. However, "rising prices during the decline in production, resulting from the revolution in Mexico, a major competitor, had masked its magnitude, kept the estate owners from shifting to other crops, and made the inevitable disaster even more complete."[17]

The greatest blow to the industry came in 1922 with the appearance of withertip disease (a fungus) among lime plantations. Within a few months of its appearance almost every estate on the island was affected. "Damage was greatest in the wet districts of rich, humus soil, at elevations above 1,000 feet, and in narrow, wet, cool valleys. Sunny, well sheltered, efficiently drained slopes, below 800 feet, were comparatively free."[18] The problems of lime growers were increased with the damage wrought by the hurricanes of 1926 and 1928. The exposed tree roots became susceptible to the red root disease.

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[17]Fentem, op. cit., p. 12.

[18]Harrison, op. cit., p. 73.

Another storm not only destroyed many of the remaining lime plantings but also many of the cocoa, coconut and citrus plantings as well.

By 1930 the full impact of the disaster was felt and estate owners at last began to diversify their production. The red root disease in limes was overcome by grafting the lime onto sour orange stock. Nevertheless, by 1935 the island had a diversified economy with lime products, bananas, oranges, cocoa, grapefruit and bay-oil accounting for three-fourths of total exports. However, lime exports in 1934 were only one twentieth of those in the peak year of 1922.

During World War II the economy had recovered from the depression of the thirties but the supply of exports to European markets could not be assured. Thus, when Madagascar supplies of vanilla were cut off from their United States market, Dominica took advantage of the vacuum and began to supply vanilla to that country. This was a precarious adventure, economically, because there was always the danger that supply lines with the Indian Ocean might be restored. Fentem describes how prices dropped drastically in New York with the news that a cargo of vanillas was on its way from Madagascar and then soared when news was received that the vessel had been torpedoed.[19] The market was very uncertain and within two years of the ending of the war, sales of vanillas fell by 77 per cent.

Location Patterns of Estate Production

Before considering the post-World War II trends in Dominican agriculture it is possible to review the development of location patterns for estates and estate production over the preceding 150 years. The pattern which emerged can be accounted for, partly, by the physical requirements of the various crops

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[19] *Ibid.*, p. 12.

produced. The earliest coffee plantations were located on the well drained slopes of the leeward coast and the river valleys near Roseau. Sturge and Harvey commented that "the beds of the river valleys are the sites of the principal estates."[20] The flat lands of some of these river lowlands were given to sugar production, even during the days when coffee was the main export. Two large sugar estates in those days included Rosalie and Hillsborough. The general trend in estate location was in the river valleys and along the coast.

The location of estates along the coast may be explained by a number of factors. The raids of runaway Negro slaves during the closing decades of the eighteenth century discouraged settlement, for a time, in the interior. Moreover, the most suitable soils were to be found along the coast and as Atwood pointed out "The lands of the sea-coast have abundantly the advantage of the interior country, for forming sugar estates."[21] A number of English planters had tried to establish sugar estates in the interior but failed and Atwood believed the reason for this was because the atmosphere was too humid.

Another factor of importance to the location of estates along the coast was the facility with which estate produce could be transported to Roseau for export. "The ocean is the highway from Roseau to most of the estates. The island is, however, encompassed and also intersected in various directions by roads which are impassable except on horses and mules."[22] There was little cooperation among estate owners and the advantages of having an estate close to the sea can be better understood when it is realized that:

> Owners of plantations near the sea saw no reason for aiding those farther inland to get their crops down easily. Planters in the interior seemed possessed by the haunting fear that their carts might not traverse a given stretch of highway

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[20]Sturge and Harvey, op. cit., p. 86.

[21]Atwood, op. cit., p. 80.

[22]Sturge and Harvey, op. cit., p. 86.

> as frequently as some neighbor's when equal contributions or allotments of negro hands to aid in the work of grading were called for.[23]

The large estates appeared with the growth of the sugar industry and in the writings of visitors to the island, mention was made of Rosalie, Belvedere, Geneva, Copt Hall and Hillsborough as some of the important sugar estates. Most of the estates referred to were in the southern half of the island and little mention was made of estate production in the north.

The location of the various crops within an estate depended on the conditions which best suited them. For example, when cocoa plantings were extended in the second half of the nineteenth century they tended to replace the sugar areas in the well sheltered valley lowlands on the leeward side of the island. Lime plantings, however, were developed on the steeper slopes which had once been in coffee and later planted in sugar. Most of the lime estates were located along the south leeward coast but there were also a few large, foreign-owned estates on the north-eastern coast which had been planted in cocoa and were later converted to lime growing. The Northeast was also the only part of the island where coconuts were cultivated on any scale. There had been a few hundred coconut trees along the shoreline of these large estates but they were not cultivated for commercial production until the early twentieth century. After disease struck the lime trees during the twenties, coconut cultivation was extended on a large number of these estates and by the thirties it was the most important coconut producing region of the island with copra making up the major part of the coconut exports.

Post War Trends

After the boom years of World War II and the collapse of the vanilla market, a new export crop appeared which would surpass all other crops in

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[23]Bryan Edwards Press, op. cit., p. 7.

importance. Several attempts had been made to establish an export market for bananas but each attempt failed because of poor internal transport and infrequent services overseas to the markets in Britain. Under these conditions it was impossible to build up a regular and reliable banana export trade. However, with substantial extension of roads financed by aid from Britain, and agreements made with Geest Industries Ltd. to have regular shipments of bananas to Britain, the production of bananas began to expand rapidly. The industry was organized through the Dominica Banana Growers' Association and every attempt was made to protect the industry from severe loss. Hurricane insurance schemes were established, fertilizer distributed, transport services organized for the bananas of small producers, and the substitution of the Gros Michel with the Lacatan banana which is less susceptible to Panama disease.

The expansion of banana production has been very rapid during the last fifteen years. Figure 1, using a running arithmetic mean over a three-year period, illustrates this trend. In 1952 banana exports were second only to lime products and contributed 25 per cent of the total domestic exports (see Table I). By 1966, however, the percentage of total domestic exports contributed by bananas rose to 74 per cent. This represented a growth in export value from $1,104,000 in 1952 to $7,420,989 in 1966. As Bartell pointed out, "banana exports have since 1961 grown to over 70 per cent of the dollar value of total exports and are increasing, while direct and indirect local value added in banana production accounts for roughly 20 per cent of the national income."[24] It might also be noted from Figure 1 that the increase in total domestic exports closely parallels the increase in banana exports.

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[24]E. Bartell, National Income Statistics Dominica 1961-1964, University of the West Indies Institute of Social and Economic Research (Eastern Caribbean), Statistical Series No. 2, p. 2.

TABLE I - MAIN EXPORTS AS A PERCENTAGE OF THE TOTAL DOMESTIC EXPORTS, DOMINICA 1952-1966 (PERCENTAGE)

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Cocoa	3.9	4.8	4.8	6.0	1.9	1.4	3.1	2.6	2.3	1.1	1.8	2.5	0.6	0.2	1.0
Copra	5.2	5.2	6.1	6.2	4.4	6.9	4.4	4.7	7.1	6.8	5.7	6.5	4.1	3.8	2.5
Bananas	24.8	38.7	54.8	54.8	65.8	65.3	55.5	68.8	67.4	65.8	64.4	69.9	79.0	78.8	74.5
Citrus	1.5	2.4	5.1	4.1	0.3	3.6	1.8	2.7	3.0	3.2	3.6	2.1	2.8	2.5	2.6
Lime juice	24.7	21.0	7.6	10.4	6.8	10.8	17.5	9.3	9.7	12.2	15.4	9.3	6.1	7.4	8.6
Lime oil	5.5	10.7	7.7	6.9	4.5	4.9	8.3	3.6	4.6	5.2	4.3	4.6	2.0	2.2	3.3
Bay oil	1.1	1.0	1.7	1.9	2.1	1.2	1.5	1.2	1.4	3.2	2.0	2.1	2.6	2.9	3.4
Vanilla	2.7	3.3	4.4	2.5	5.9	0.3	2.3	2.4	0.7	0.2	neg.	0.2	neg.	neg.	neg.
Total	69.4	87.1	92.2	93.8	91.7	94.4	94.4	95.3	96.2	97.7	97.2	97.2	97.2	97.7	95.9

Source: Figures for 1952-1963 from Colonial Office Reports on Dominica 1956-1965. Figures from 1964 to 1966 from the Statistical Office, Roseau, Dominica.

The success of the banana industry and its importance in the export trade may be explained by the changes in market demand for bananas in Britain. During the fifties there was an increase in the demand for the fruit in Britain and the Windward Islands quickly began production to supply that demand. In 1954 the Windward Islands supplied only 6.8 per cent of Britain's banana imports, but by 1965 they were supplying 45.7 per cent of those imports.[25] An attractive aspect of banana cultivation is that bananas provide a quick cash return and is therefore very popular with small farmers as well as estate producers who cannot afford long-term outlays of capital. Harvesting is not confined to any particular time of year and the cultivation of this crop provides year round employment.

The second most important export commodities are lime products viz. lime juice and lime oil. These products accounted for the largest share of domestic exports till 1953 when they were surpassed by bananas. Since then the percentage contributed by lime products to total domestic exports decreased from 30 per cent in 1953 to 12 per cent in 1966. Lime exports have encountered mixed fortunes with a decline in the mid-1950s followed by a general increase in exports until 1962 (Figure 1). The overall export value of these exports has fallen slightly from $1,341,000 in 1952 to $1,184,696 in 1966.

The importance of lime products in the domestic export trade may be attributed to the increase in the value of lime products added by processing.

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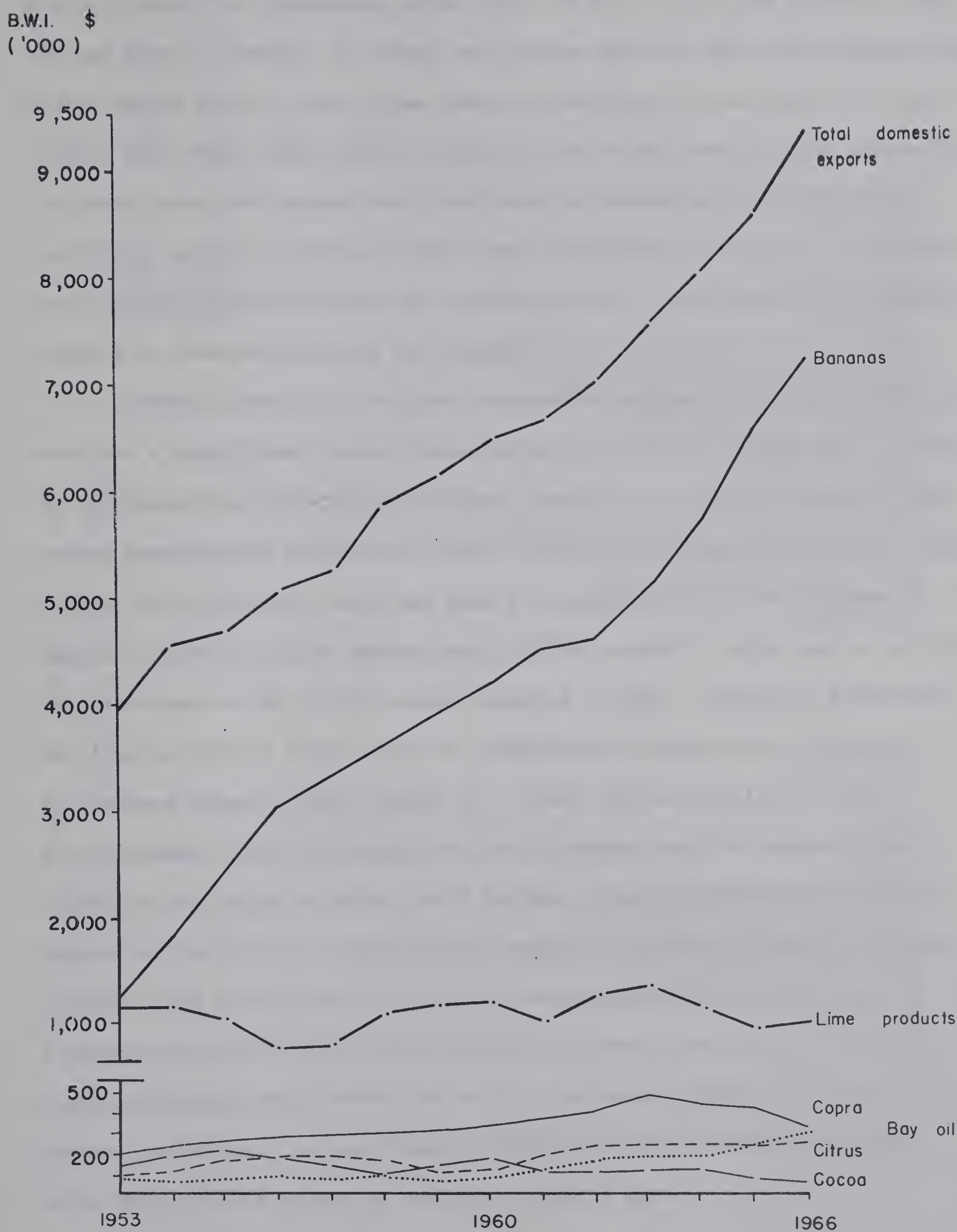
[25] B. Persaud, An Abstract of West Indian Banana Statistics, University of the West Indies Institute of Social and Economic Research (Eastern Caribbean), Statistical Series No. 3, 1966, p. 53. The Report of the Tripartite Economic Survey to Barbados and the Windward and Leeward Islands noted that "bananas produced in countries outside the Commonwealth have to pay a tariff of 7.10s. a ton, while a quantitative restriction limits to 4,000 tons the volume of bananas which may be imported from 'dollar-area' countries." J.R. Sargent, et al., Report of the Tripartite Economic Survey of the Eastern Caribbean, H.M.S.O., London, 1967, p. 37.

Fig. 1 Trends in main exports, 1953 - 1966.



SOURCE : Figures for 1951 - 1963 are taken from the Great Britain Colonial Office Reports, <u>Dominica</u>, H.M.S.O. London, 1958 - 1967. Figures for 1964 - 1966 were provided by the Statistical Office, Roseau.

Bartell noted that processing added over 100 per cent to the purchase value of raw limes. However, he points out further that if there were markets which would absorb all the fresh limes used for producing oil and juice, then the return from these limes would be equal to the value added in lime processing.[26] In other words the income from limes could be maintained if there was a sufficient market for them. Fresh limes are exported and sold in local markets in other islands within the Caribbean area. The prospects for expanding exports to these markets are not bright.

Although grapefruit had been produced on estates in the study area they were not a significant export commodity until the end of World War II. Owing to the precarious marketing procedures, Dominica's grapefruit exports fluctuated considerably during the 1950s. During this decade there was a general decline in exports but there has been a resurgence since 1960 (Figure 1). Exports in 1967 totalled approximately 55,000 crates[27] which was a considerable increase on the 19,200 crates exported in 1960. Dominican grapefruit are sold in Britain where there is considerable competition from South African and Israeli fruit (Figure 2). South African supplies on the British market fall off towards the end of August and the imports from Israel do not begin to arrive until October. During September there is a demand for the fruit; a demand which Dominica can supply because its fruit matures a few weeks earlier than the Israeli crop. Prices are higher in September, but these high prices required by Dominican grapefruit (to cover higher shipping costs) endure for only a few weeks. When the Israeli fruit arrives prices drop and any Dominican grapefruit which arrives in London after this fall in prices is usually sold at a loss.

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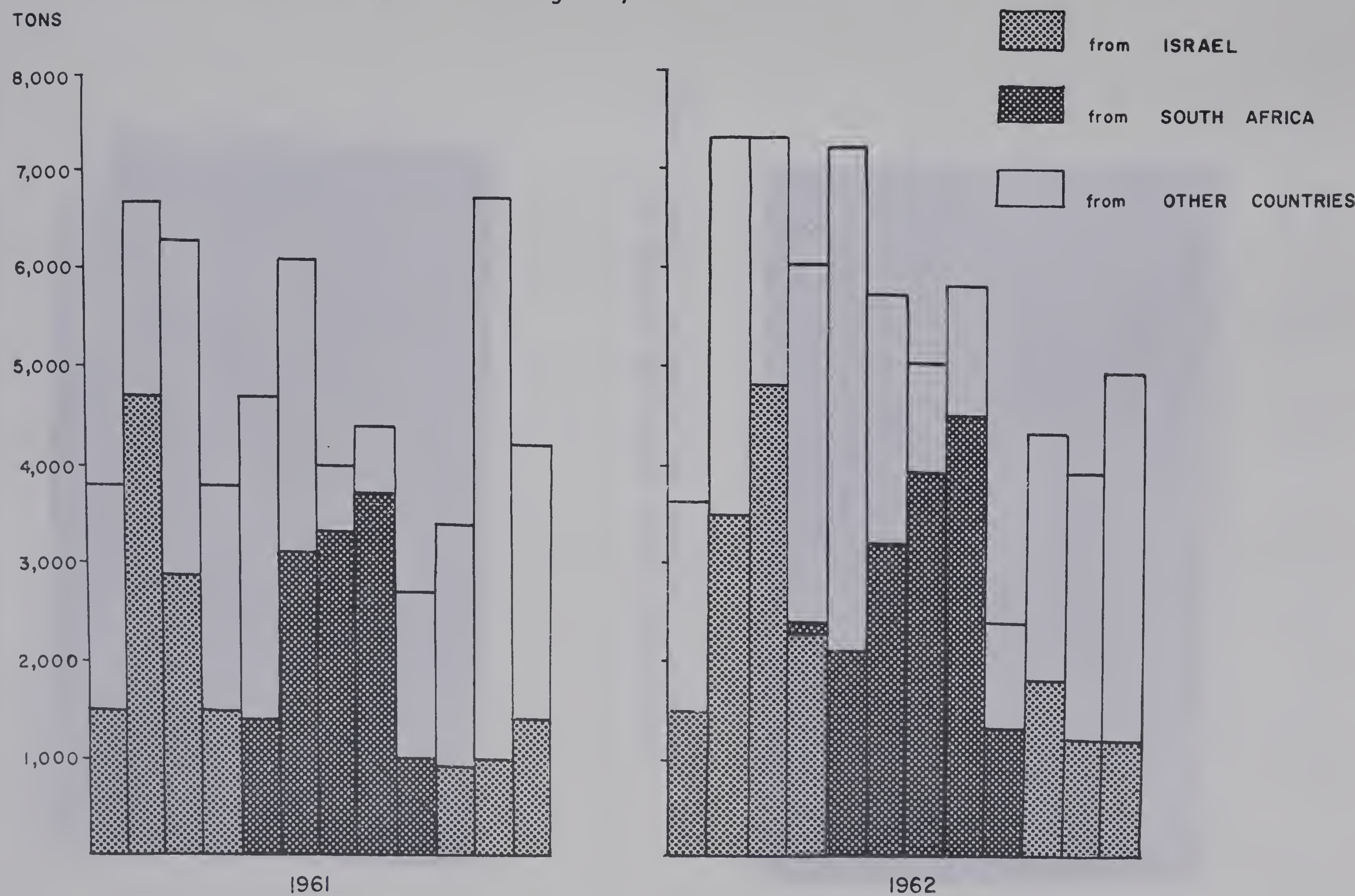
[26]Bartell, op. cit., p. 4.

[27]C.J.L. Dupigny, personal communication, January 1968.

Fig. 2 Monthly imports of grapefruit into the United Kingdom, 1961 & 1962



SOURCE : Commonwealth Economic Committee, Fruit, H.M.S.O. London, 1964, p.96.

Plate 3. Roseau, the capital and main port, is situated on an alluvial fan created by the Roseau River.

Plate 4. The square in Roseau is the island's chief market for ground provisions and other produce from the small landholdings.

Oranges were also exported to Britain but these exports have almost ceased since 1950 because of high shipping rates and the inability to compete with oranges from Israel and other Mediterranean producers. Most of the orange crop is now sold within the Caribbean, to Barbados, Martinique, Guadeloupe, Antigua, St. Croix and occasionally to Curacao. Although prices are good the extent of the market is limited. Trade restrictions are imposed by Martinique and Guadeloupe at certain times of the year to protect their own growers. The trend in orange exports has been very similar to that for grapefruit (Figure 1). There was a general decline in exports during the late 1950s but exports have revived considerably since 1960. Approximately 9,000 crates were exported in 1966. However, because of the limited markets for this fruit a large part of the crop is allowed to rot each year on a large number of estates. This situation may be remedied if a citrus canning factory is established on the island.

Among the other products which are exported from Dominica, only copra and bay-oil showed an increase during the last 15 years. However, this increase has been very slight. Copra was exported from a number of large estates in the northern part of the island to Barbados. The value of copra exports has shown only a slight increase from $230,000 in 1952 to $250,016 in 1966. This represented a decline in the percentage of total exports from 5 per cent (1952) to 2.5 per cent(1966). However, this gives no indication of the increasing importance of copra production and coconut growing in the agriculture of the island. The establishment of a coconut products factory in 1965 means that although the required quota of copra is still sent to Barbados, much larger quantities are being processed in Dominica.

Bay-oil is produced by the distillation of phenol from the leaves of a native West Indian tree, <u>Pimenta racemosa</u>. Exports of bay-oil increased from $50,000 in 1952 to $338,494 in 1966. This figure could

be much higher if more efficient methods of distillation were used.

Conclusion

The economy of Dominica is still very definitely an agricultural one with a heavy dependence on the success of a single crop (Appendix A). Attempts to diversify the economy would probably be most successful in the agricultural sector as the possibilities for developing industry are limited. Already, the coconut industry is showing signs of growth and although markets for citrus fruits are limited, citrus production could be expanded if a proposed citrus canning factory were built. Such an expansion would help diversify the agricultural economy, and there is evidence that grapefruit production will increase as new plantings mature and begin to bear fruit.

The tendency in the past has been towards dependence on a single export crop. The dangers of such an economy have been experienced no less than three times already in Dominica's history. Economic stability in the last 150 years has invariably been closely linked to the conditions of tropical commercial agriculture viz. its vulnerability to rapid changes in world markets and the ravages of crop diseases, pests and hurricanes.[28] Fentem remarks that "four times already Dominica's economy has crested on sales of a dominant crop, and three times a trough has followed the wave. There is no reason to expect that history will not repeat itself a fourth time."[29] Such a claim for the historicist viewpoint may be held in dispute, but the point is clear. Should the banana industry fail, despite the precautions which have been taken, the economic consequences for the island would be overwhelming. The agricultural economy of Dominica requires diversification.

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[28]Fentem, op. cit., p. 4.

[29]Ibid., p. 15.

Plate 5. On some of the larger estates, young grapefruit trees are interplanted with bananas.

Plate 6. Grapefruit production will increase as these new plantings mature and begin to bear fruit.

CHAPTER III

ESTATE AGRICULTURE

A. Introduction

The Contribution of Estates

The growth and decline of the different crops in the export economy of Dominica has been discussed in Chapter II. The relative importance of the crops in the agricultural economy today can be assessed from Table II which shows the

TABLE II - LAND USE IN ACRES (APPROX.)

Land Use	Acres
Orchard Crops	(Total) 20,170
Limes	1,800
Grapefruit	1,390
Oranges	980
Coconuts	10,000
Cocoa	6,000
Bananas	20,000
Food crops	4,000
Pasture land	4,500
Woodland	25,330
Total	74,000

Source: Personal communication J.H.C. Grell, Dept. of Agriculture, Roseau, 1967.

approximate acreage of the main crops for the entire island. Bananas are by far the most important crop and are as important as all the orchard crops combined, while coconuts account for the greatest extent of all the orchard crops. It will be noticed that of the 74,000 acres recorded as farm lands, 25,330 are in woodland. Much of this forest and woodland is found on the larger landholdings, particularly those over 500 acres in size (Table III).

TABLE III - DISTRIBUTION OF LAND USE IN ACRES BY SIZE OF HOLDING, DOMINICA, 1961

Size of Holdings	Number of holdings	% of total acreage of farmland	Permanent cropland	Other cropland	Cultivated grassland	Uncultivated grassland	Woodland and forest	Other land including ruinate	Built on and service
0 - 1	2115	1.2	544	306	7	15	-	-	3
1 - 5	4290	12.1	5274	2322	250	689	542	18	81
5 - 10	1410	11.0	3655	1167	44	341	3099	48	25
10 - 25	546	10.0	2846	854	93	573	3191	63	24
25 - 50	131	5.6	1459	354	32	375	1995	38	19
50 - 100	78	6.6	1211	735	75	192	2774	36	27
100 - 200	36	6.4	1399	404	7	199	2672	156	23
200 - 500	37	14.9	2659	1336	39	195	6823	220	102
500 +	24	32.2	5843	1315	84	1126	15,977	98	90
	442*								
Total	9,109	100.0	24,890	8,793	631	3,705	37,073	677	394

* Holdings without land

Source: Unpublished West Indies Census of Agriculture 1961.

Much of the farmland in Dominica is held in large landholding units. There were 175 landholdings over 50 acres in size according to the agricultural census taken in 1961 (Table III) and these accounted for 1.9 per cent of the total number of landholdings. However, these 175 holdings accounted for 60.1 per cent of the total farmland and 44.6 per cent of the permanent cropland.

From a second reading of these figures it becomes evident that the larger landholdings or "estates" over 50 acres in size, do not contribute as proportionally high a share of agricultural production as we might expect. Finkel, in his survey of 1962, found that many of the estates were worked well below their optimum capacity of production[1] and "most of the good and reasonably level land lies in the large estates, where it is, with a few exceptions, not efficiently used.... Furthermore, there are considerable tracts of land lying in the estates which are not in production at all."[2] Campbell also pointed out that this "substantial amount of unused land [exists] in areas already served with roads; much of which is privately owned."[3] The amount of unused land held in estates is very high and the landholdings of 50 acres or more in size account for 28,246 acres or 76.2 per cent of all the woodland occurring on farms.

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[1]H.J. Finkel, Report on Agricultural Development in Dominica, St. Kitts, Nevis and St. Lucia, Institute of Social and Economic Research, University of the West Indies, Kingston, Jamaica, 1962, p. 8.

[2]Ibid., p. 13.

[3]L.G. Campbell, The Development of Natural Resources in Dominica, Institute of Social and Economic Research Agricultural Series No. 3, University of the West Indies, Port of Spain, Trinidad, 1965, p. 3.

It should be clear that although estates contain a large proportion of all farmland including some of the best farmland in Dominica, the importance of estate production in the general agricultural production of the island should not be overestimated. Bartell pointed out in his National Income Statistics, Dominica 1961-1964, that "small land holdings have accounted for 86% of the total factor payments in the banana sector during 1961 and 81% during 1962 although since that time this percentage has fallen due to expansion of a few large commercial estates."[4] Bartell does not indicate what is meant by "small land holding" but it seems unlikely he was referring to land holdings greater than 50 acres in size.

Comparative figures are not available which would indicate the volume of other export crops contributed by estates and small holdings. It should be realized that the banana is a crop which may mature in 10 months and therefore provides a quick cash return. For this reason it is a particularly attractive crop for the small farmer with limited capital and who depends upon a quick cash return. The other orchard crops such as citrus, coconuts and cocoa will take five years and more to reach maturity and this delay in cash return for heavy capital outlay is not easily borne by the small producer. Moreover, the uncertain marketing procedures for grapefruit and oranges involve a risky outlay of capital which tends to discourage small producers from making such an investment. However, those having a larger land holding and greater capital backing can more easily afford this outlay using bananas as a catch crop for the first few years until the orchard crops mature. It would seem unlikely, then, that owners of small land holdings would account for so large

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[4]E. Bartell, National Income Statistics, Dominica 1961-1964, University of the West Indies, Statistical Series No. 2, Bridgetown, Barbados, July 1965, p. 2.

a percentage of the citrus or copra exports as they do for banana exports.

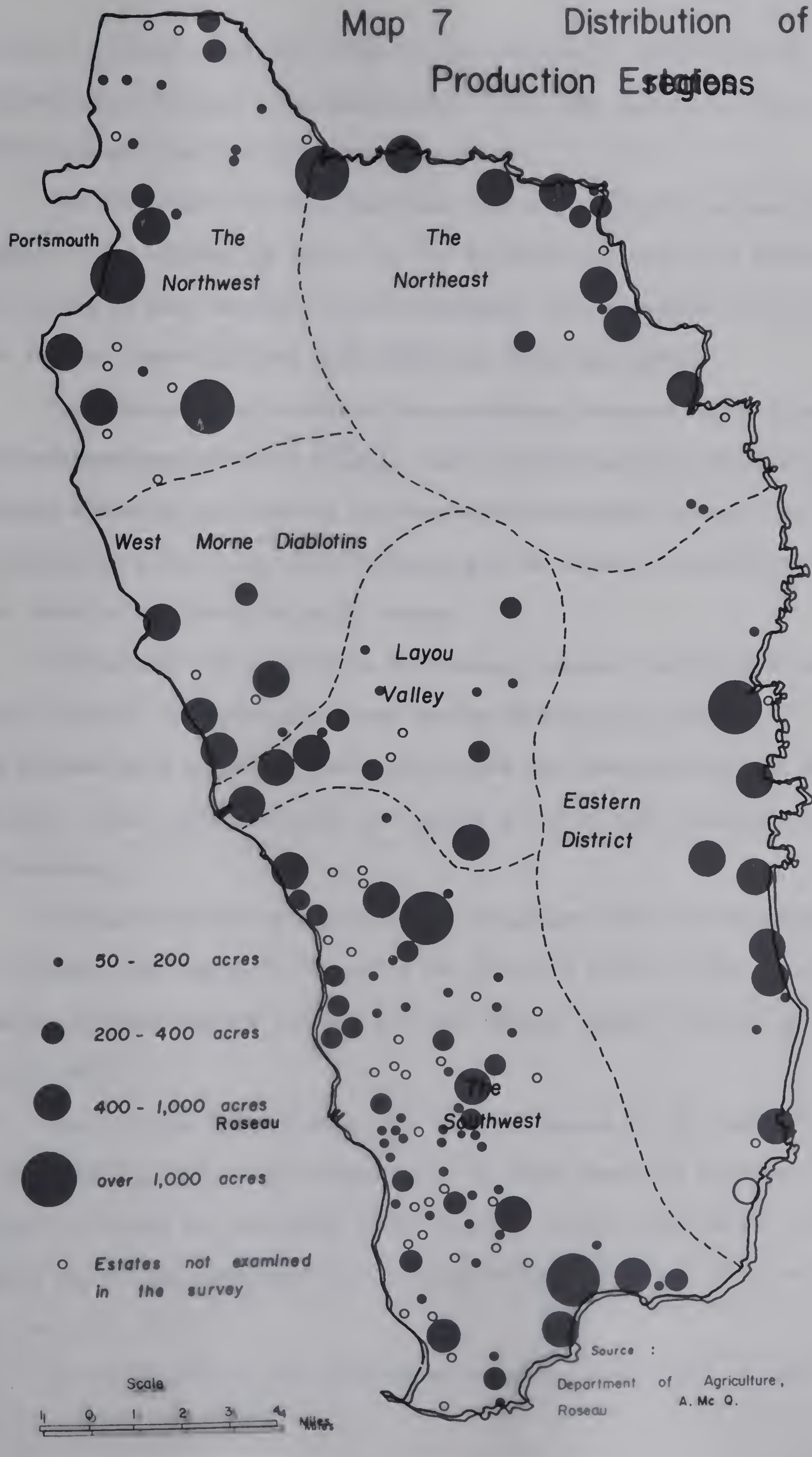
Distribution of Estates

The agricultural census of 1961 enumerated 175 land holdings of 50 acres or more in size and 119 of these landholdings were examined in the summer of 1967. Map 7 shows the distribution of estates by size throughout the island. The larger estates, i.e. those over 400 acres in size, seem to be located with no definite pattern being scattered throughout the island. Smaller estates, particularly those of less than 200 acres seem to be concentrated in the southwestern quadrant.

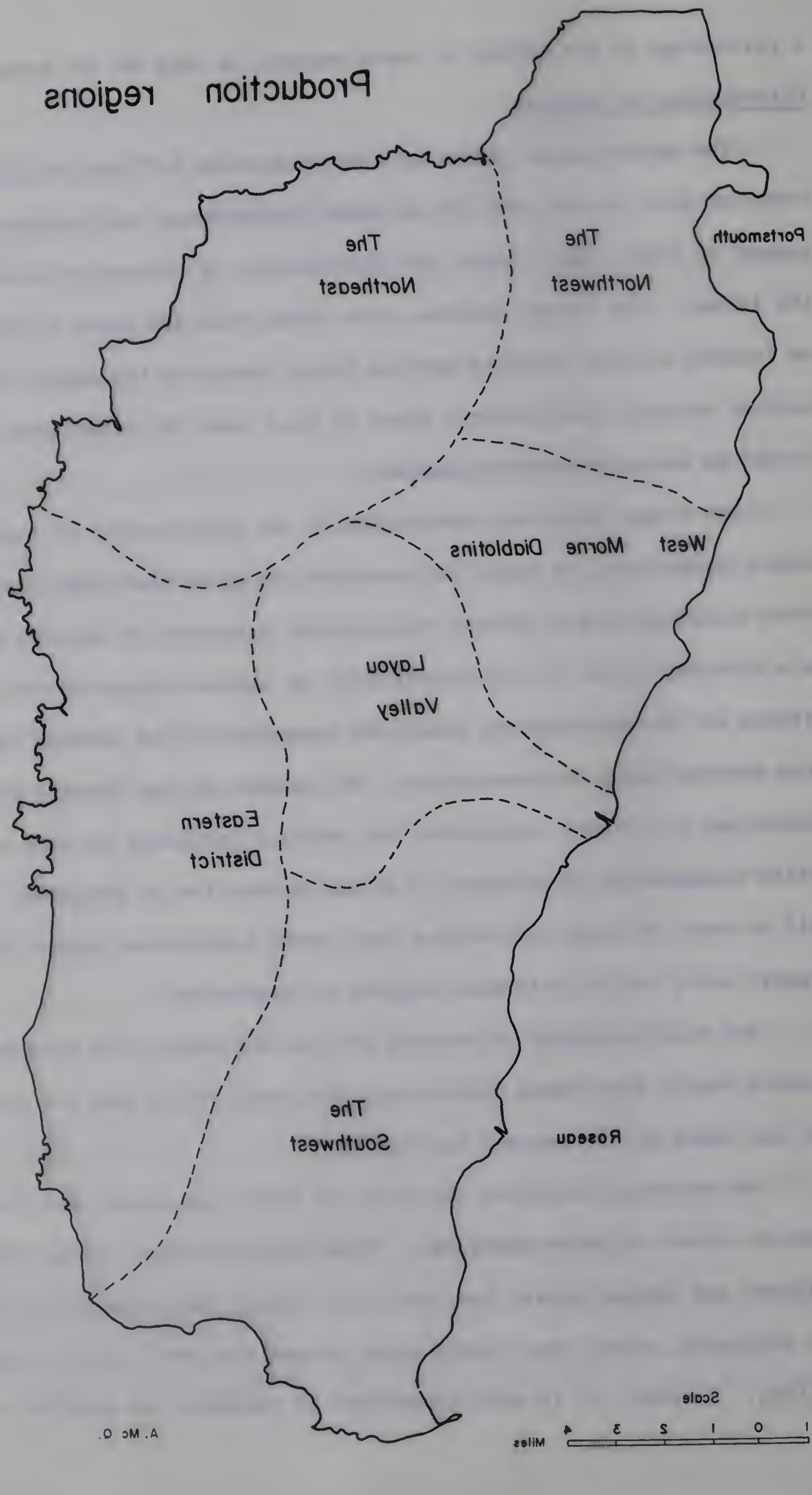
For a more detailed examination of the distribution of estates and estate production, it would be convenient to group them into districts. These districts are in effect only spatial groupings of estates e.g. there is a distinct break in the distribution of estates along the west coast. The estates of the southeastern coast are separated by the central upland ridge from estates along the west coast. The estates on the leeward side of the island may be further subdivided into smaller groupings so that a more detailed examination of patterns of estate production is possible. An attempt will be made to group the estates into areas having some degree of physiographic unity and to establish regions of production.

The main groupings of estates are the Northwest; the Northeast; the Eastern Coast; West Morne Diablotins; the Layou Valley and the Southwest, and are shown on the overlay for Map 7.

The Northwest includes the Morne au Diable peninsula and the northwestern slopes of Morne Diablotin. This latter section, lying between the Colihaut and Indian Rivers has little in common, physiographically, with the peninsula, other than fairly steep slopes and small narrow river valleys. However, it is more convenient to consider the estates of this



Map 7 Distribution of Production Estates


Production regions
The Northeast
The Northwest
Portsmouth
West Morne Diablotins
Layou Valley
Eastern District
The Southwest
Roseau
Scale
1 0 1 2 3 4
Miles
A. Mc G.


Map 7 Distribution of Estates
50 - 200 acres
200 - 400 acres
400 - 1,000 acres
over 1,000 acres
Estates not examined in the survey
Scale
1 0 1 2 3 4
Miles
Source :
Department of Agriculture, Roseau.

southern section along with those of the peninsula, rather than to group them separately or as part of another region. Both the peninsula and the southern sector are part of the Portsmouth hinterland.

The Northeast, on the other hand, has a much higher degree of physiographic unity consisting mostly of the northeastern slopes of Morne Diablotins. The relief is more moderate in the Northeast than elsewhere on the island and the land is generally less than 1000 feet above sea level.

The Eastern District stretches southwards from the Pagua River to the southeastern corner of the island. Most of the district consists of the eastern slopes of the central volcanic ridge which fall sharply to the Atlantic and includes a few large river valleys such as those of the Castle Bruce, Rosalie, Wanarie and Pointe Mulatre Rivers.

The western flank of Morne Diablotins, between the Colihaut and Layou river valleys, has uniformly steep slopes falling off to the sea. The slopes are drained by a number of youthful streams and there are no well developed valleys. This region includes the driest parts of the island and has very few estates.

The Layou Valley is a distinct physiographic unit in the central part of the island. The valley is broad in the interior where it stretches for more than seven miles inland but has a narrow outlet towards the sea at the western end.

South of the Layou Valley, the western slopes of the central ridge are steeply sloping and deeply dissected by a large number of streams. The largest of these are the Check Hall, Roseau, Gillon, Soufrière and Geneva Rivers which have developed fairly large valleys and some flat land along the valley bottoms.

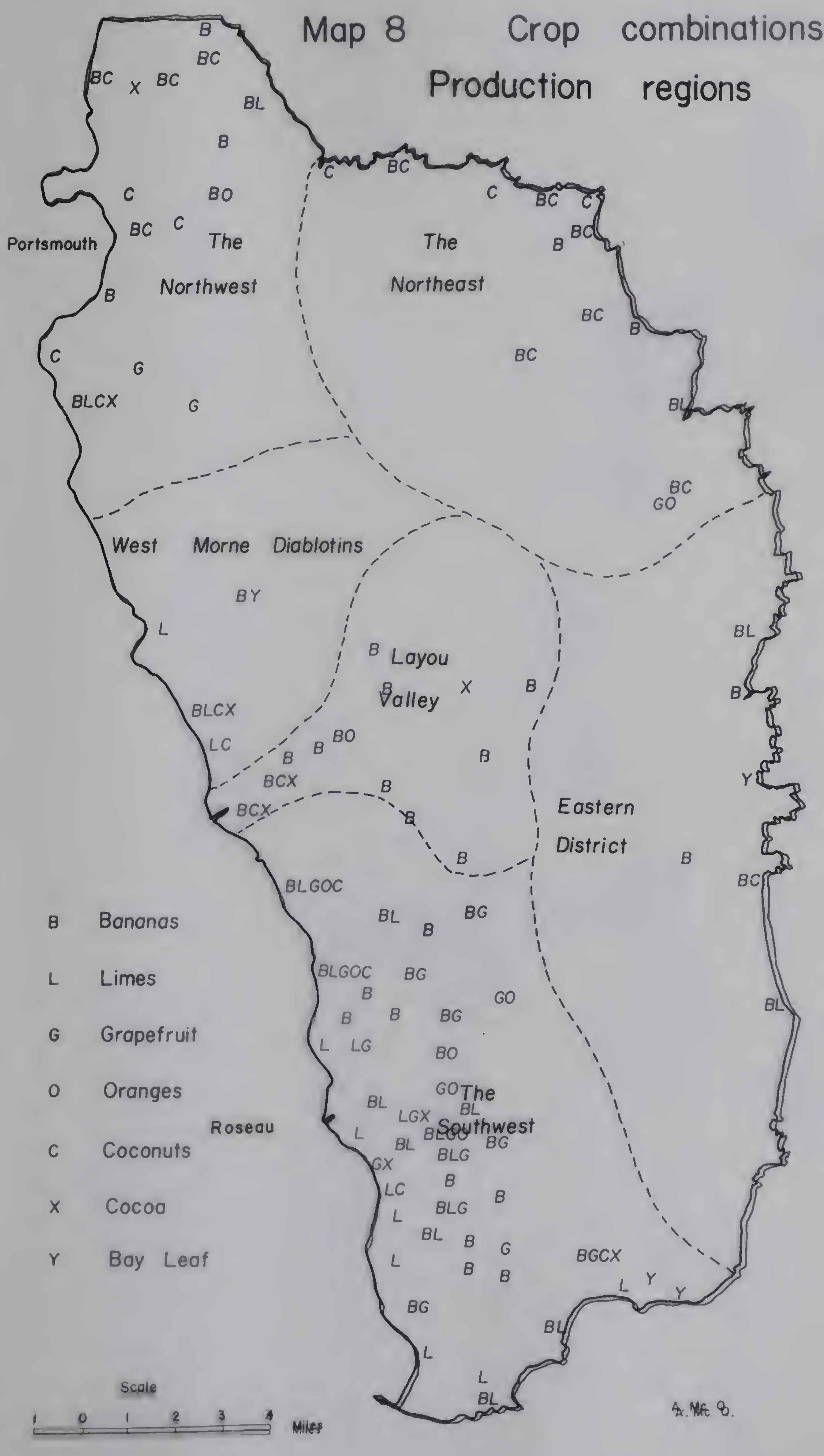
Before turning to the discussion on estate production, a brief state-

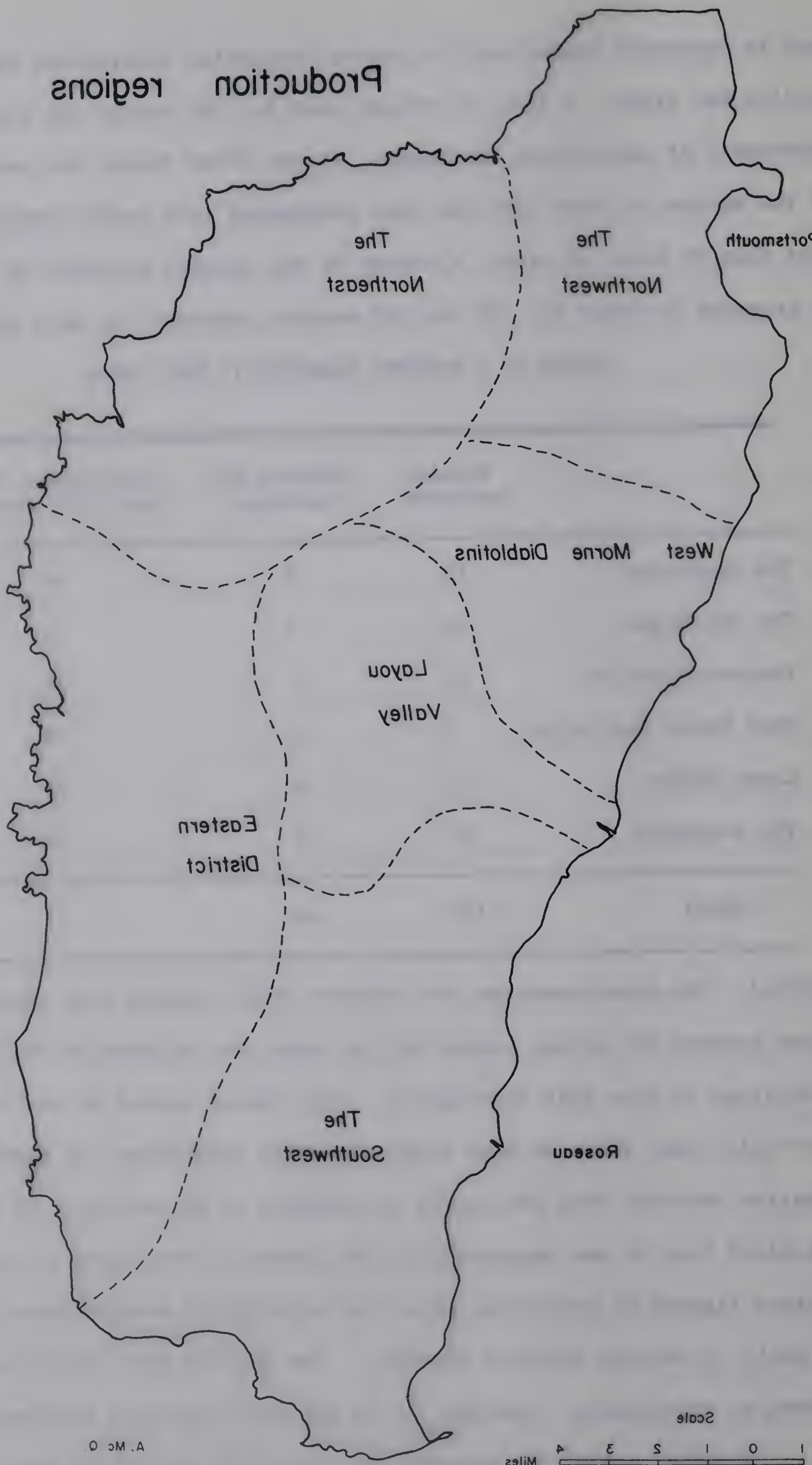
ment is necessary concerning the survey from which information of estate production was drawn. A list of estates used for the survey was supplied by the Department of Agriculture in Roseau. It was found during the survey that five of the estates on this list had been fragmented into small landholdings of less than 50 acres in size. A resume of the estates surveyed in each region is provided in Table IV. Of the 120 estates surveyed ten were found to be

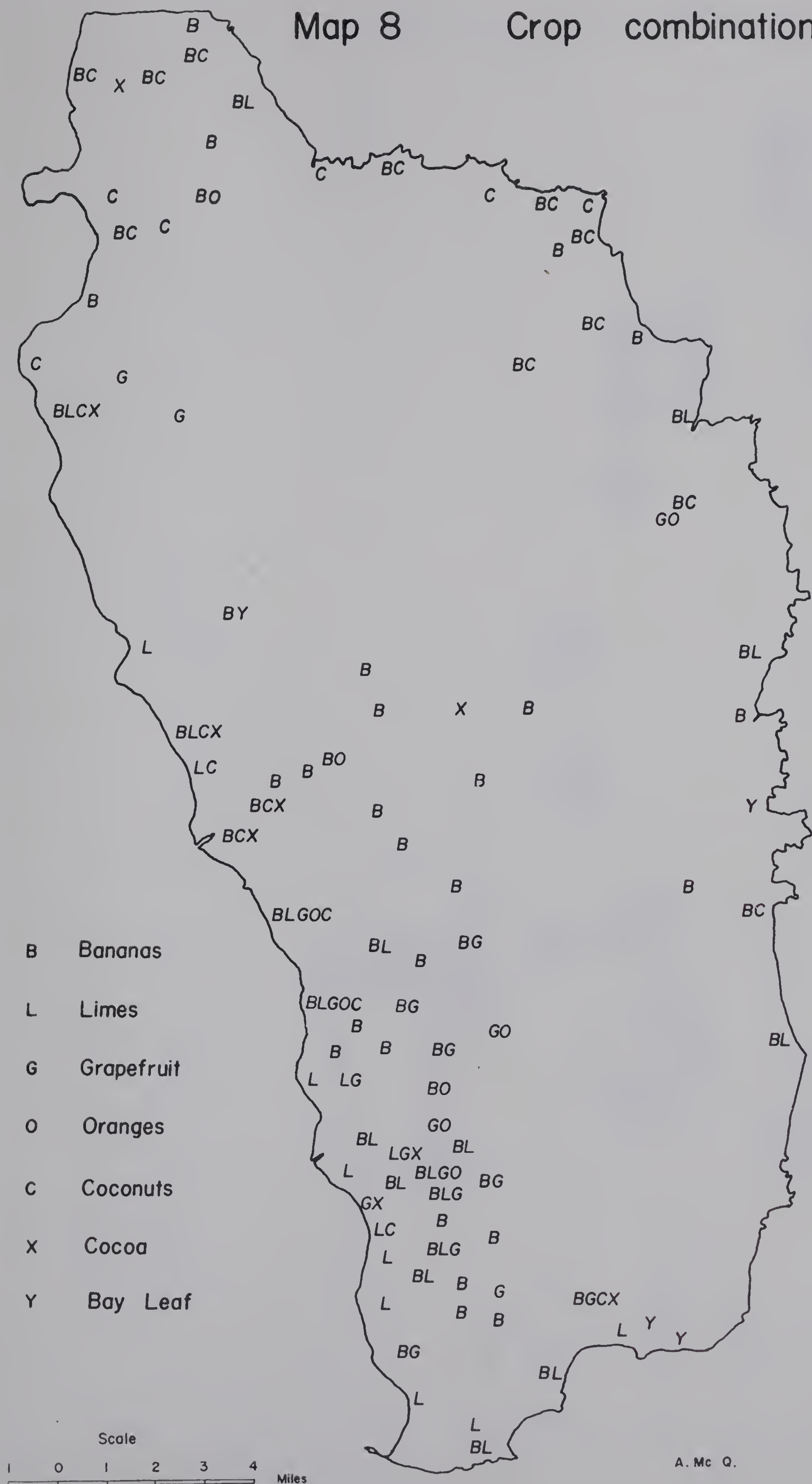
TABLE IV - ESTATES EXAMINED IN THE SURVEY

	Estates surveyed	Estates not surveyed	Percentage of the total not surveyed
The Northwest	18	9	36
The Northeast	14	3	12
Eastern District	10	3	28
West Morne Diablotins	6	2	25
Layou Valley	13	4	23
The Southwest	59	27	34
Total	120	49	-

moribund. The questionnaires for thirteen other estates were incomplete either because the estate owners did not know the information being sought or declined to give this information. The figures quoted in the following description (and shown on Maps 8-16) of estate production are based on information received from the owners or managers of 96 estates. It should be emphasized that it was impossible in the course of the survey to obtain accurate figures of production since the majority of estate owners are not in the habit of keeping detailed records. The results must therefore be considered as approximate. However, it is believed that this information is generally reliable, useful for purposes of comparison and is the best approximation obtainable.

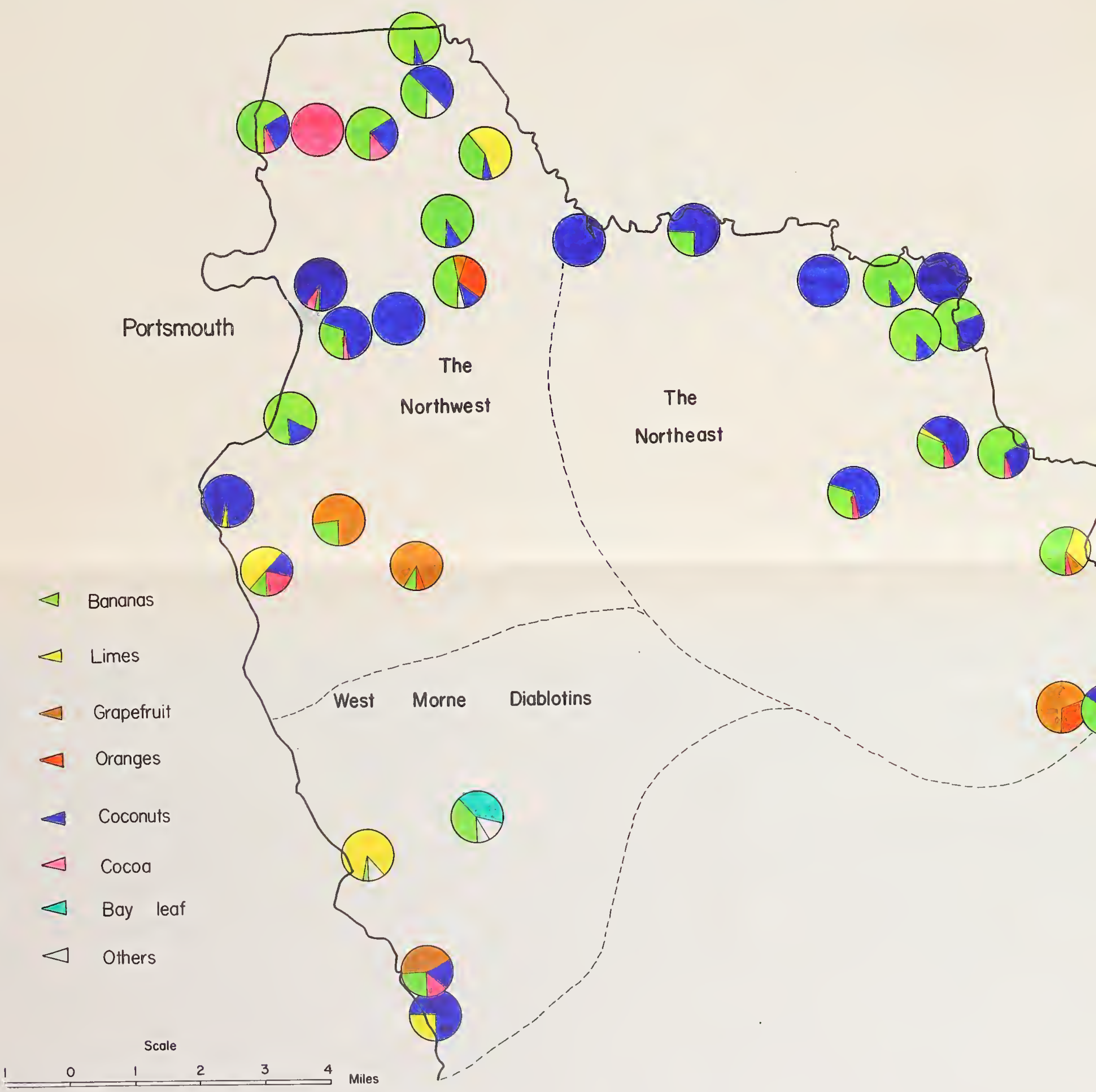

Map 8 Crop combinations
Production regions
The Northwest
The Northeast
Portsmouth
West Morne Diablotins
Layou Valley
Eastern District
The Southwest
Roseau
B Bananas
L Limes
G Grapefruit
O Oranges
C Coconuts
X Cocoa
Y Bay Leaf
Scale
1 0 1 2 3 4 Miles
A. Mc Q.


Production regions
The Northeast
The Northwest
Portsmouth
West Morne Diablotins
Layou Valley
Eastern District
The Southwest
Roseau
Scale
1 0 1 2 3 4
Miles
A. Mc Q.

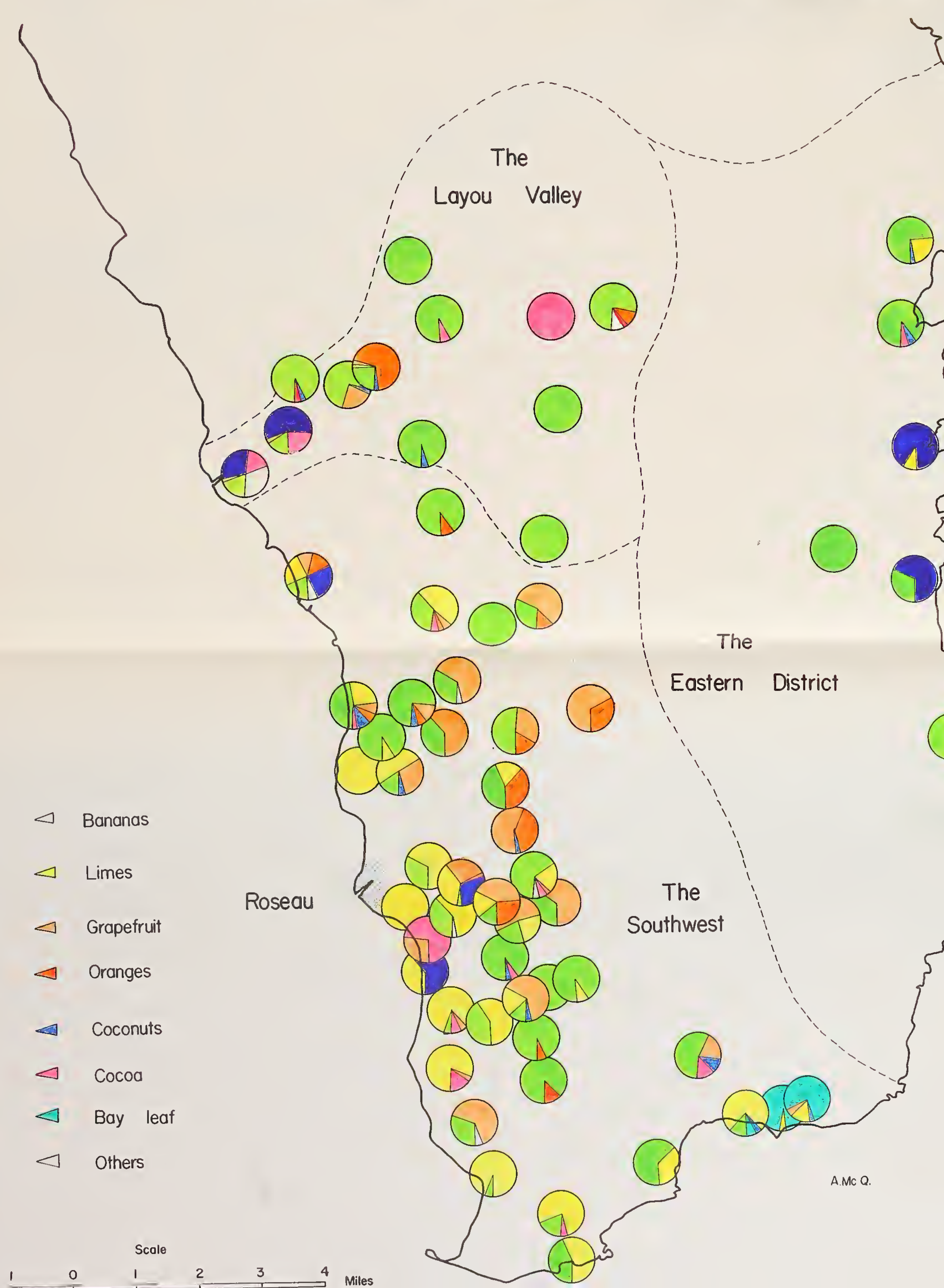

Map 8 Crop combinations
B Bananas
L Limes
G Grapefruit
O Oranges
C Coconuts
X Cocoa
Y Bay Leaf
Scale
1 0 1 2 3 4
Miles
A. Mc Q.

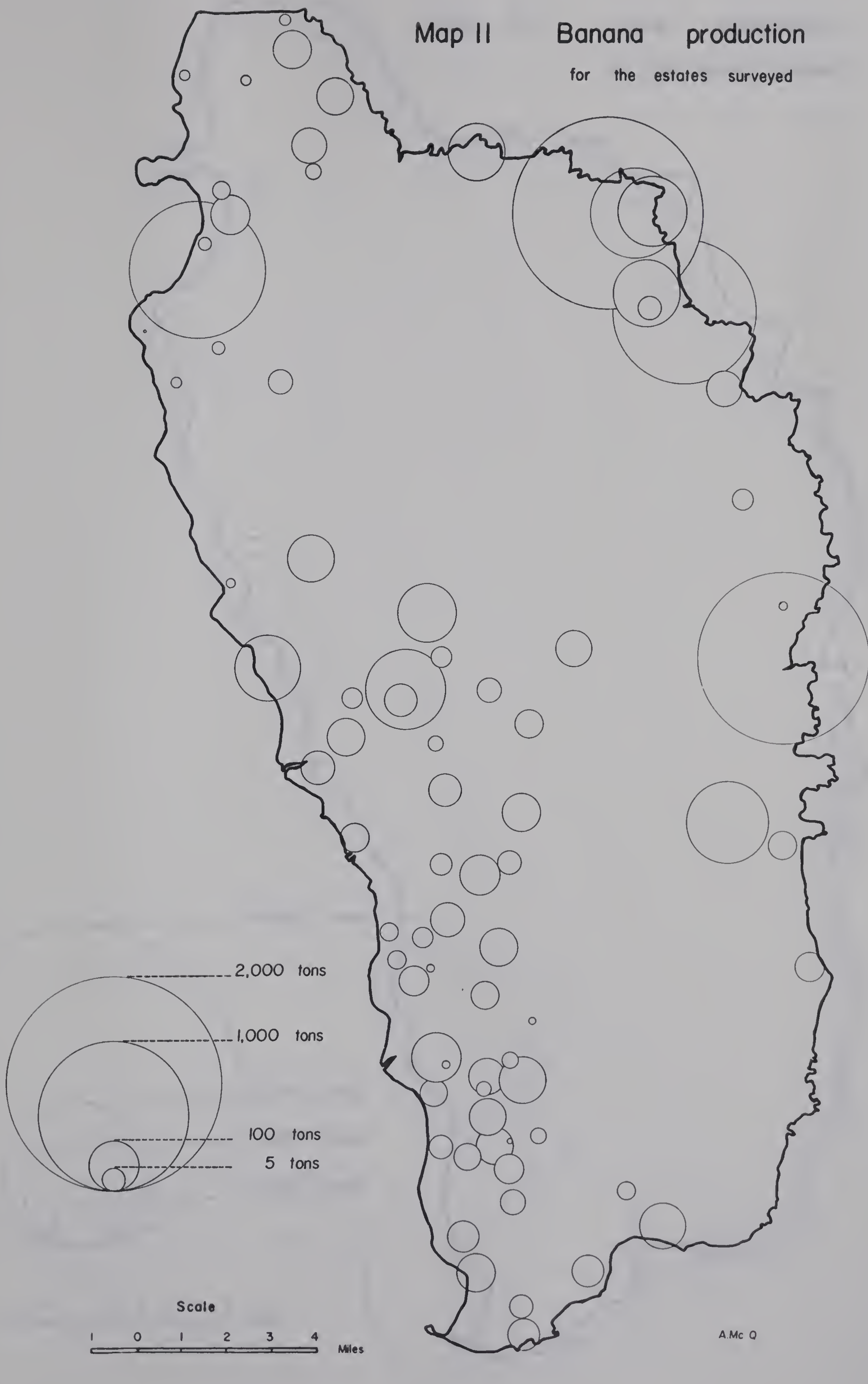
Map 9 Income from crops as a percentage of total income

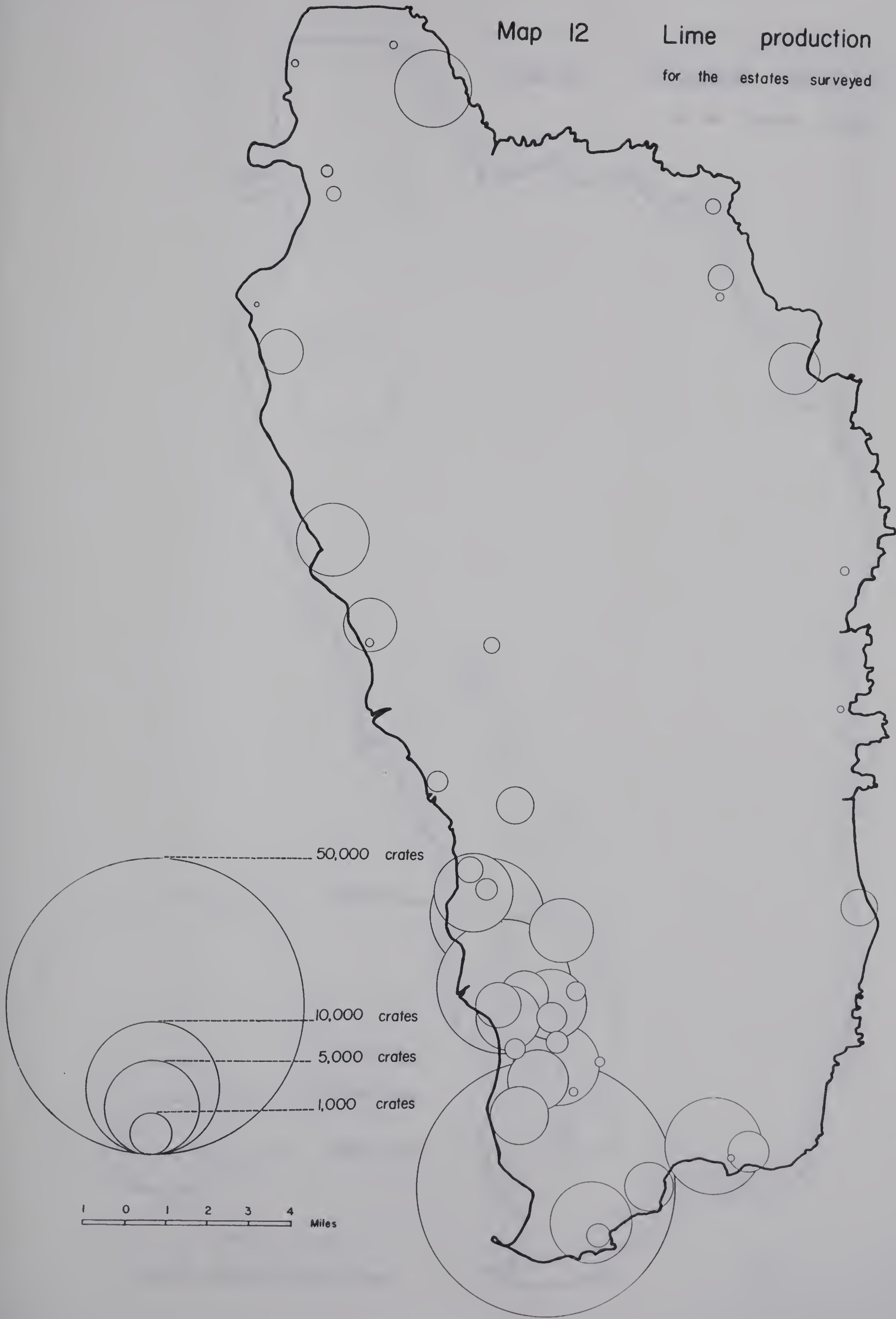
for estates surveyed in the Northwest, Northeast and West Morne Diablotins.

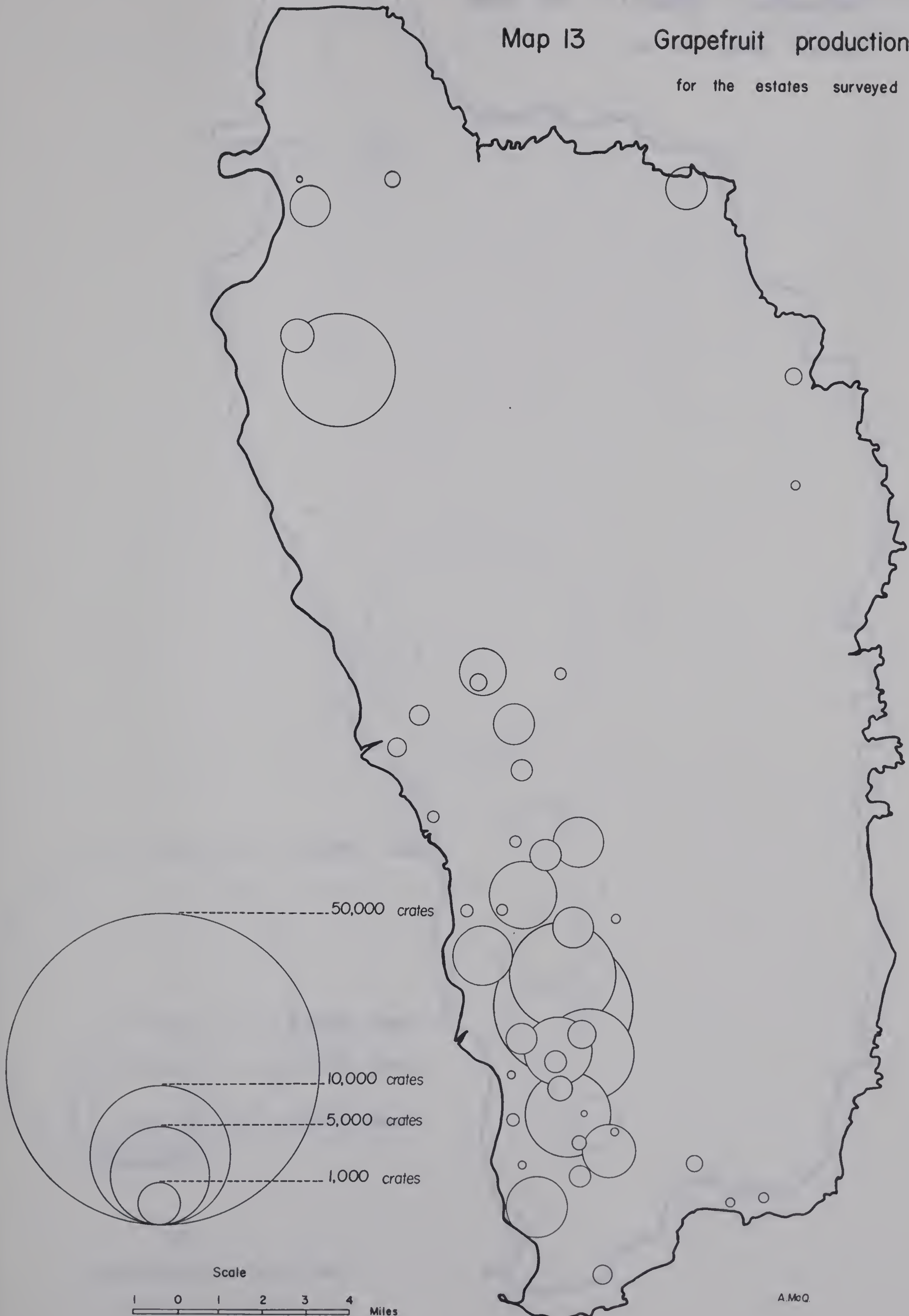


Map 10 Income from crops as a percentage of total income for the estates surveyed in the Eastern District, Layou Valley and the Southwest.




Map 11 Banana production
for the estates surveyed
2,000 tons
1,000 tons
100 tons
5 tons
Scale
1 0 1 2 3 4
Miles
A.Mc Q

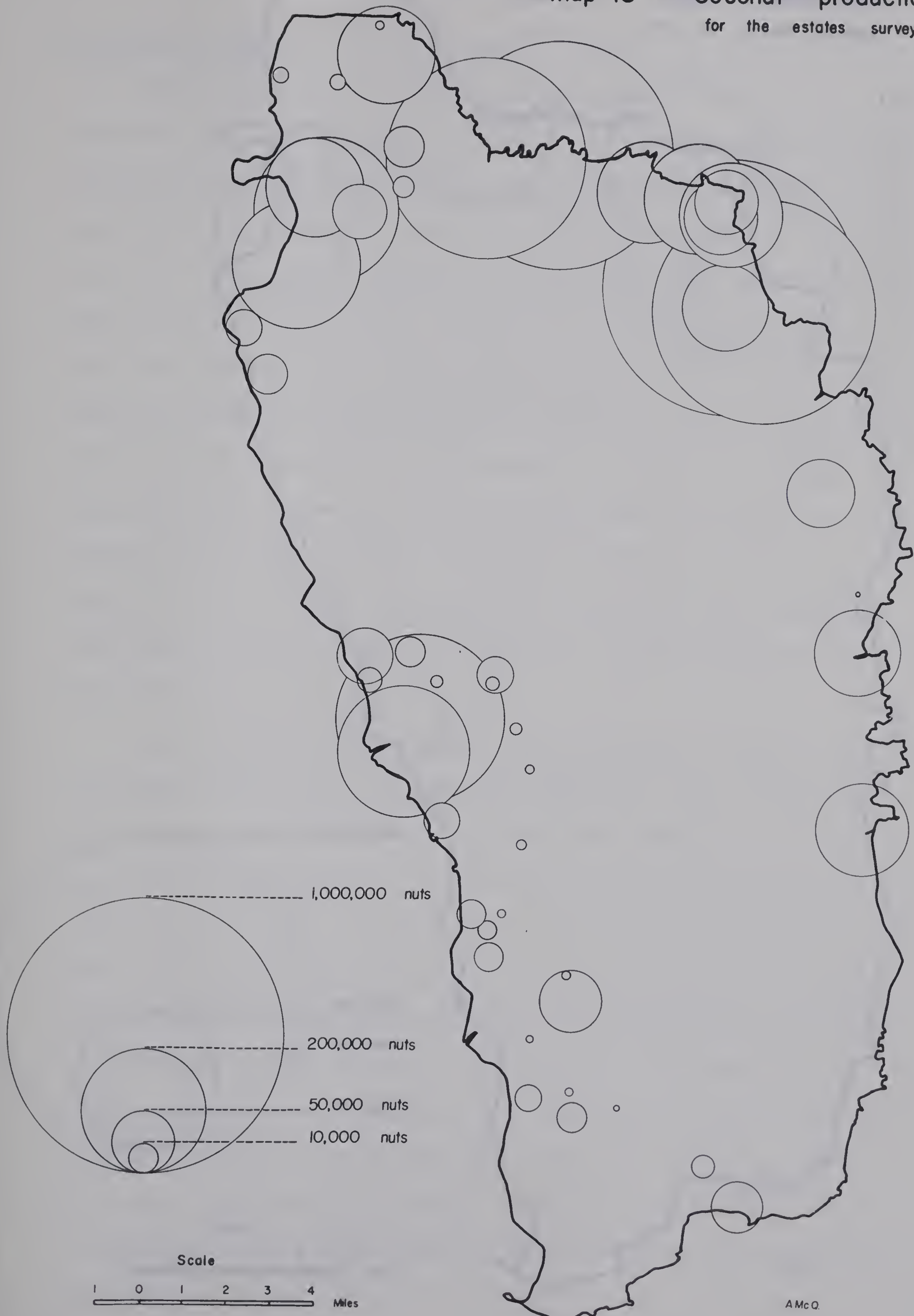

Map 12 Lime production
for the estates surveyed
50,000 crates
10,000 crates
5,000 crates
1,000 crates
1 0 1 2 3 4
Miles

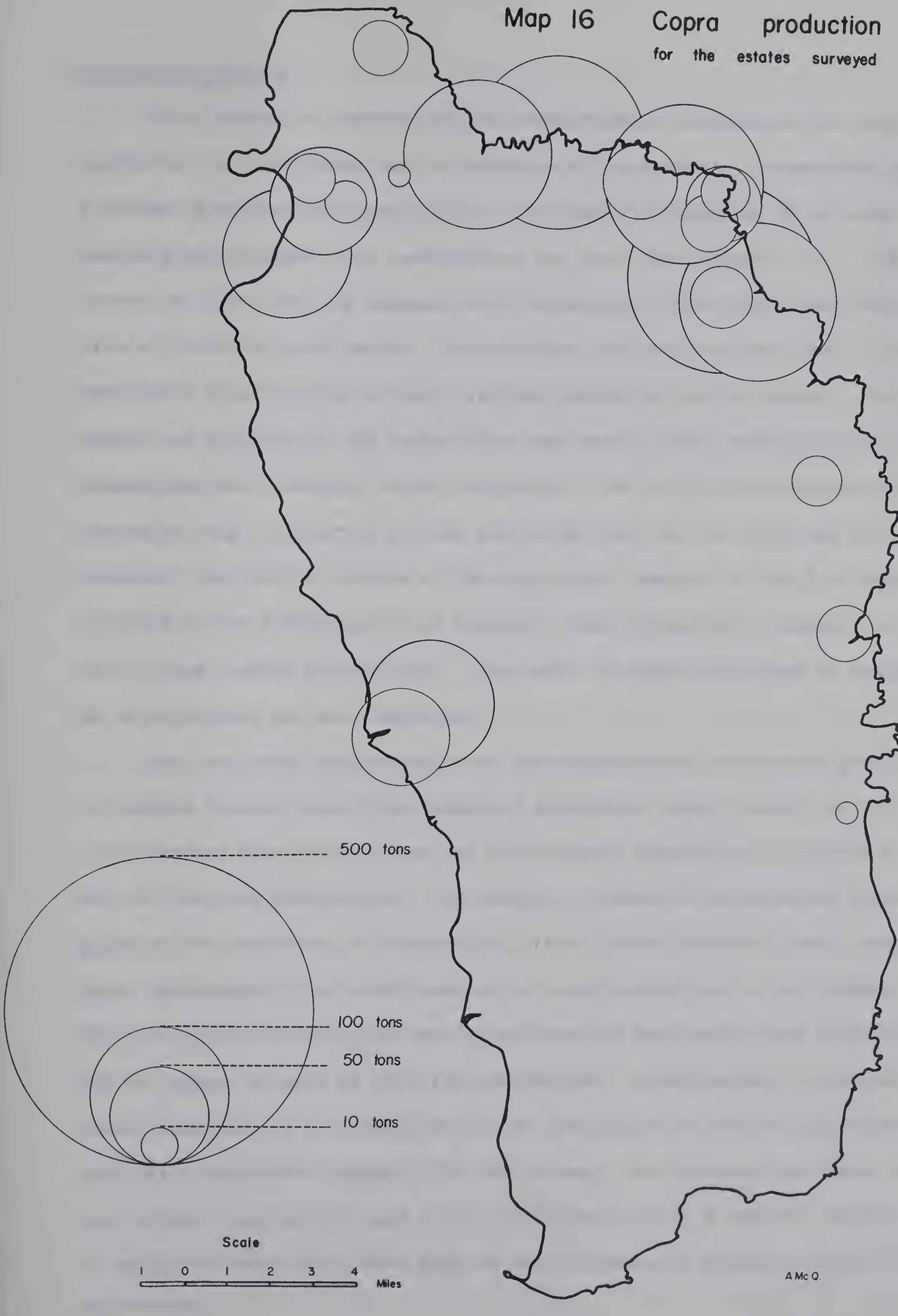

Map 13 Grapefruit production
for the estates surveyed
50,000 crates
10,000 crates
5,000 crates
1,000 crates
Scale
1 0 1 2 3 4
Miles
A.MacQ.


Map 14 Orange production
for the estates surveyed
50,000 crates
10,000 crates
5,000 crates
1,000 crates
Scale
1 0 1 2 3 4
Miles

Map 15 Coconut production

for the estates surveyed




Map 16 Copra production
for the estates surveyed
500 tons
100 tons
50 tons
10 tons
Scale
1 0 1 2 3 4
Miles
A Mc Q.

B. Production Regions

This attempt to describe estate production is focussed on the volume of production for each crop, and the patterns of production. To describe the patterns of agricultural production, J.C. Weaver's technique of variance analysis to determine crop combinations was used (see Appendix D). The cash return for each crop was computed as a percentage of the total cash return from all crops on each estate. The variance analysis was then used to determine which crop combination best typified production on the estate. The emphasis was entirely on the return from cash crop so that production for domestic consumption and livestock is not considered. The aim of the analysis was to determine crop combination so that percentage rank of the crops was not considered. The initial letters of the crops were inserted on Map 8 as they occurred in the following order: bananas, limes, grapefruit, oranges, coconuts, cocoa, coffee and bay leaf. The order of letters provides no indication as to which crop was most important.

Once the crop combinations have been established it was then possible to examine in more detail the ranking of individual crops, as well as the production of those other crops not sufficiently significant to appear as part of the crop combination. For example, a number of estates may be engaged in the production of bananas and citrus (which includes limes, grapefruit and oranges) with small amounts of cocoa production on each estate. The cocoa production was not very significant on each estate and therefore did not appear as part of the crop combination. Nevertheless, it was sufficiently important to be considered in the description of estate agricultural production within the region. For this reason, the relative importance of the various crops within each estate was shown on Maps 9 and 10. However, it should be noted that these maps do not indicate the volume of production on estates.

The next step in describing estate production was to consider the volume of production for each crop. This led to a comparison of production of the region to the remainder of the island. In this way, the relative importance of the regions could be established for the major crops produced.

The Northwest

The estates in the Morne au Diable peninsula are less than 400 acres in size. Most of the estates have a two crop combination, one of the crops invariably being bananas. The other crop was either limes, oranges or coconuts. Coconuts are grown on almost all of the estates although it does not always show up in the crop combination. Another crop which seldom appears in the crop combination (Map 9) is cocoa. Nevertheless, cocoa is grown in small quantities on a large number of estates and this represents the remnants of a period when cocoa production was widespread throughout the island.

To the south of Portsmouth, the estates are generally larger than those to the north and several are over 400 acres in size. The larger estates show a tendency towards a single crop predominance of either bananas, coconuts, or grapefruit. Bananas, however, are grown on all of the estates.

The most significant crops in the Northwest are bananas and coconuts. However, the region supplies only 13 per cent of the banana production from estates covered by the survey. It is the second most important coconut producing region, supplying 15 per cent of coconut production. The Northwest could not be regarded as an important citrus growing district although it did supply 19 per cent of the grapefruit, 4 per cent of the oranges and 2 per cent of the limes. The cocoa produced in the region accounted for 10 per cent of total production by the estates surveyed.

The Northeast

The Northeast can more easily be referred to as a region, not only with respect to its physiographic unity, but also in terms of uniformity of estate

production. Most of the estates are between 400 and 1000 acres in size and all are engaged in large scale production of cash crops. Several of these large estates are owned by foreign-based companies such as Woodford Hill (Geest Industries) and Melville Hall (Commonwealth Development Corporation) and are worked with a high degree of efficiency in terms of cultivation practices and use of manpower. The Northeast is also a region of banana and coconut production (Map 15). Bananas and coconuts are a common two crop combination on most estates and on those estates with a single crop predominating that crop is invariably either bananas or coconuts (Map 9). Even in the southern part of the region on one estate where bananas and citrus are important, coconuts are also grown. Unfortunately, the owner of this estate keeps figures of coconut production along with those of another estate within the region and coconuts do not appear as a part of the estate production. Citrus are not generally important in the Northeast region, although a few limes are grown on two or three estates. Citrus production was more important a decade ago and Fentem pointed out in 1960 that until a few years previously there was no road connection with Roseau and "citrus rotted for lack of a market, and cocoa provided only limited revenue."[5] After the road connection was completed "bananas have contributed most to economic change and almost half of the 1959 banana acreage was located in this region."[6] In the Clyde Valley, some cocoa is still grown and sent to Melville Hall for export. Again, however, the quantities of cocoa produced are not great.

As can be seen from Maps 15 and 16 this is the most important coconut and copra producing region in Dominica. The region accounted for 66 per cent

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[5]A.D. Fentem, Commercial Geography of Dominica, Indiana University, Bloomington, Indiana, 1960, p. 8.

[6]Loc. cit.

Plate 7. In the Northeast extensive banana plantings are found on the undulating, less rugged slopes.

Plate 8. Contour planting is utilized to prevent erosion.

of the coconut production and 71 per cent of the copra production indentified by the survey. Bananas are also produced on a larger scale in the Northeast than elsewhere in the island and it accounts for 39 per cent of total banana production. Citrus production is small and limited to a few estates accounting for 2 per cent of the limes, 3 per cent of the grapefruit and 2 per cent of the orange production.

The Eastern District

The Eastern District is characterized by a few estates strung along the coast, the majority of them being between 400 and 1000 acres in size. Many of the estates were moribund until the early 1960s when a road was built connecting Castle Bruce and Rosalie with Roseau.[7] Since then, there has been a revival of cultivation on a few estates, yet many remain inactive today. The estates are generally located in the larger river valleys.

There is no particular crop combination which typifies production within the eastern district. Bananas are grown in varying quantities on all estates, and the C.D.C. estate at Castle Bruce is producing very large quantities of bananas (Map 11). This estate accounts for the majority of estate grown bananas in the Eastern District. The entire district accounted for only 15 per cent of total banana production. Other crops include coconuts and limes. Coconut production is limited to two estates and this accounts for 4 per cent of the total coconut production. Limes are grown in very small quantities and contribute only .1 per cent of the total.

A recent trend in estate cultivation in this district has been the introduction of grapefruit. A few estates in the eastern district have interplanted grapefruit with bananas, but these grapefruit plantings have not begun

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[7] Ibid., p. 9.

Plate 9. Castle Bruce Estate in the Eastern District occupies the flat bottom-land of the Castle Bruce River, but is now extending up the valley sides.

Plate 10. Bananas are planted in the flat bottom-land; coconuts are planted along the seafront and on the valley sides.

to bear fruit yet. Through time it is expected that the acreage of bananas will be reduced as the grapefruit mature, and grapefruit will come to make a more significant contribution to estate production in this district.

The Eastern District has been known for the number of pimenta racemosa trees found along the coast, the leaves of which are used for distilling bay oil. The gathering of bay leaves is not important on the large estates on the east coast but provides revenue for the smaller estates and the fragmented landholdings which once comprised larger estates. One estate owner who has just come to Dominica, now living in the district, intends to introduce other shrubs and plants for large scale production of perfume oils.

West Morne Diablotins

There are few estates in this, the driest part of Dominica. Those that do fall in the 400-1000 acre group. This region is similar to the Northwest and the Eastern District in that no particular crop combination typifies estate production. Bananas are grown on all estates, but other crops range from limes and coconuts to bay leaves. Small amounts of coffee for the local market are still produced on several estates, as well as some cocoa and sugar cane.

This region is not important for estate production. All but two estates were surveyed and yet the region accounted for only 6 per cent of the bananas, 5 per cent of the limes, 1 per cent of the coconuts and 9 per cent of the cocoa produced on all estates covered by the survey. These low figures are obviously due to the small number of estates in this district. In the northern part of the district there are but a few small estates. This "gap" in the distribution of estates provides the break between this western flank of Morne Diablotins and the group of estates further north and included in the Northwest. The paucity of estates may be due to the low rainfall and poor quality of the soils. Fentem suggested that the "deficiency of soils is attributed both to

destructive coffee cultivation until the 1830s and over-exploitation by peasants since that time."[8]

Layou Valley

The Layou Valley contains small to medium size estates of less than 400 acres in size. Three estates larger than 400 acres are found in the lower section of the valley, towards the sea (Map 7). Most of the estates have a single crop predominance and that crop is usually bananas. The region could therefore be described as a banana monocrop region (Map 8).

Other crops are found on a large number of estates but are seldom as important as bananas. For example, cocoa is grown on a number of estates (Map 10) and this may be attributed to the fact that a Cocoa Propagation Centre flourished in the Layou Valley some years ago. Many estate owners probably planted considerable acreages in cocoa at the time when the marketing prospects for cocoa were bright. Today the Layou Valley accounts for 65 per cent of the total cocoa production by the survey.

Coconuts are important on two of the larger estates at the western end of the valley but are not important in any of the other estates. Their importance on these two estates may be due to the proximity of the Coconut Products factory at Belfast Estate, a few miles to the south. The Layou Valley, however, accounts for only 12 per cent of coconut production.

Although banana production is widespread in the Layou Valley, the entire region accounts for only 10 per cent of banana production. There is none of the large scale production in this Western District such as is found in the Northern and Eastern District (Map 11). Generally, citrus are not very important in the Layou Valley and only 6 per cent of the total grape-

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[8] Ibid., p. 8.

fruit production comes from this region. One estate, however, is engaged in the large scale production of oranges and this estate provides most of the 70 per cent of the total orange production from all estates on the island (Map 13).

The Southwest

The southwestern and southern part of Dominica contains the largest concentration of estates to be found in any region. The majority of estates are less than 200 acres in size and only 10 are greater than 400 acres in size. Of the total 76 estates within the region, 30 estates (31 per cent of the total) were not covered by the survey. This is the highest percentage of non-coverage for any region so that percentage figures quoted for comparison may not be truly representative and may be slightly biased against the Southwest. (Table III)

The Southwest might easily be called the banana and citrus region because all estates are engaged in either (and very often both) the production of bananas and citrus (Map 8).

Although banana production is widespread and is found on almost all of the estates, the scale of production is modest compared with the Northeast region. Estates generally produce less than 15 tons of bananas per year (Map 11) and in total they account for only 17 per cent of total banana production.

Citrus production seems to show very definite distribution patterns. Estates producing limes are found clustered along the coast in the southwest and around Roseau. The lime processing factories in Roseau may help explain this concentration of lime production. The region produced 77 per cent of the total lime production and this is obviously the most important lime producing region in Dominica.

Orange production is not found along the coast but on the estates situated a few miles inland. This "zone" of orange production is clearly

visible in Map 14. The growing of oranges is not sufficiently important on most estates to ensure that they appear as part of the crop combination. However, Map 14 shows that oranges are grown on a number of estates in the upper parts of the river valleys. The Southwest accounts for 27 per cent of total orange production.

The pattern of grapefruit production is very similar to that of oranges, although the "zone" of production on Map 13 is obscured by the greater quantities of grapefruit produced. On almost all estates engaged in grapefruit production, small quantities of oranges are produced and there seems to be a strong correlation between the distribution of both crops. The large quantities of grapefruit production may be explained by the fact that the grapefruit market is better established and more assured than the orange market. The Southwest accounted for 71 per cent of total grapefruit production, so that this region is not only the most important lime producing region, but also the most important grapefruit producing one.

Small amounts of cocoa are produced in the Southwest and they account for 16 per cent of total cocoa production. As in the case of the Layou Valley and Morne au Diable peninsula, most of this cocoa comes from remnants of cocoa plantings which were once more widespread. Many of these cocoa plantings are now falling into disuse or being cleared for other crops such as grapefruit or bananas.

In the extreme southeastern part of this region, several estates sell bay oil, distilled from leaves gathered on the estates. This is a continuation of the bay leaf cultivation referred to along the southeast coast in the Eastern District. Coconut production is sporadic and on a small scale (Map 15), and accounts for only 13 per cent of total coconut production. This figure may have been slightly higher if figures had been available for a large estate on the south coast which is largely concerned with coco-

nut production.

Before concluding this discussion it should be noted that there are areal groupings of estates which cannot be clearly recognized as regions of estate production. For example, the Northwest and West Morne Diablotins have no internal unity and are simply groupings of convenience. The estates in these areas cannot be grouped within another district. However, other districts have emerged from this discussion as clearly recognizable regions of estate production. These regions show a uniformity of crop combinations and crop production. Within these regions there are strong similarities in the scale of production, e.g. banana production in the Northeast is mostly on a large scale on a few large estates (Map 11), whereas production in the Southwest is widespread on a large number of estates but on a much smaller scale (i.e. less than 15 tons per annum). Coconut production in the Northeast is also on a large scale which distinguishes it from coconut production in the remainder of the island.

The Northeast is a region of large scale coconut and banana production: the Layou Valley and the Southwest are regions of small scale banana and citrus production. Even within the Southwest zones of lime and grapefruit/orange production are recognized. The Eastern District is characterized by a few large estates, some still moribund, and the remainder producing bananas on a limited scale.

Now that variations in the patterns of production and variations in the volume of cash crop production throughout Dominica have been established, it is possible to look for a relationship between these variations and transportation facilities.

CHAPTER IV

TRANSPORTATION

The Growth of Transportation Facilities

In Dominica, as in most other Lesser Antillean islands, the main port is located on the leeward coast. Roseau has always been the main outlet for agricultural exports, although a smaller centre at Portsmouth in the north has been used occasionally. The nineteenth century road patterns in Dominica reflected the pre-eminence of the capital. In fact, throughout much of the nineteenth and early twentieth centuries there were few roads on the island except in the vicinity of Roseau. Some of the roads still used along the western coast are remnants of the French colonial period. In other more isolated parts of the island the only connection with Roseau was by small, dugout canoe or lighter along the coast. L.C. Harrison wrote of transportation in 1935:

> There are no roads and ninety-two miles of so-called highway are mainly steep gradient trails and bridle paths.... Head carriage and donkey pack are the major two methods of transport by peasants, both of products for the export trade and of articles for barter or sale in the local markets.... Until very recently, most export crops have been of the type that permit of concentration, or that will stand rough transport. Scores of canoes gather the crops from the little bay heads and concentrate them at the port.[1]

The windward coastal district continued to use these small canoes for the transport of agricultural goods to Roseau until the late 1950's when a road connection was finally built. Today, water transportation for

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[1] L.C. Harrison, "Dominica - A Wet Tropical Human Habitat," Economic Geography, Vol. 11, 1935, p. 64.

estate produce is utilized only on the leeward coast. One estate still has no road connection with Roseau, and the produce is taken by motor powered boat to a point where road transportation to Roseau is available. Limes are occasionally taken by lighter from Portsmouth to Roseau but the volume is insignificant. The use of head carriage and pack animals (mainly donkeys) for transport occurs only on a few estates which are inaccessible to motor transport. These estates produce very small quantities of goods for export.

The most important methods of transportation today are by truck and jeep. Much of the agricultural produce from estates is transported to Roseau by estate owned trucks. However, estate owners occasionally hire other trucks to help with transportation when the volume of goods to be transported cannot be handled by their own trucks. Those estates which produce small quantities of goods may send their produce on one of the daily "buses" going to Roseau. These buses, which are really covered trucks with removable wooden benches, are also used on Thursdays and Fridays (banana buying days) for carrying bananas from various parts of the island to the ports.

Roads

In 1949 there were only 75 miles of arterial (or main) roads and 53 miles of feeder roads in Dominica.[2] The arterial roads converged on Roseau from Geneva, Laudat, Riversdale and Batali (Map 17). In the north a few roads were developed from Portsmouth. The main road extended as far as Deux Branches and shorter stretches also ran along the coast to the north and to the south of the town. There was no motorable connection between Roseau and Portsmouth and the road network of the island was incomplete.

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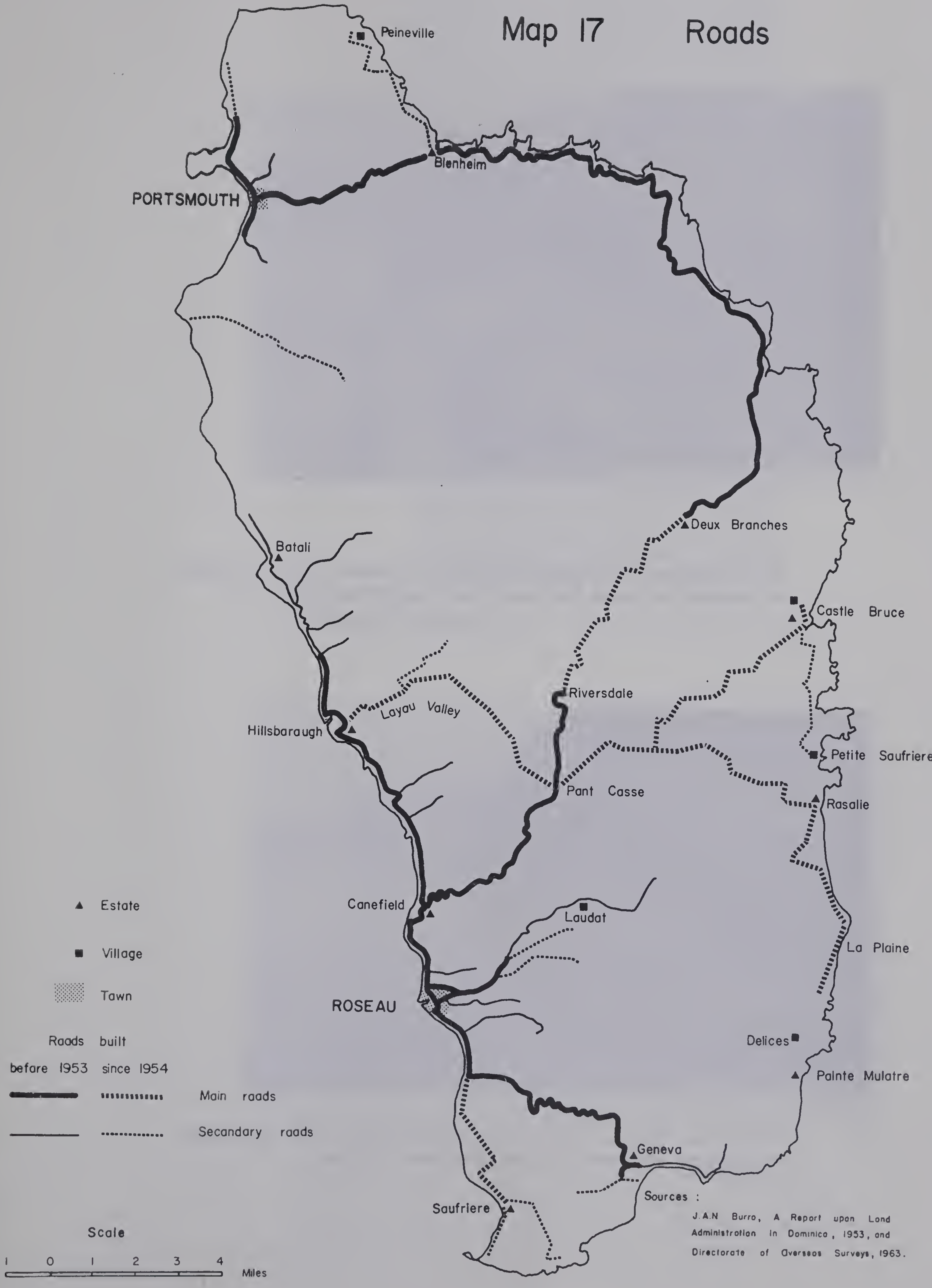
[2] J.A.N. Burra, A Report upon Land Administration in Dominica, Roseau, 1949, (mimeographed), Appendix I.


Peineville
Blenheim
PORTSMOUTH
Deux Branches
Batali
Castle Bruce
Riversdale
Layou Valley
Hillsborough
Petite Soufriere
Pont Casse
Rosalie
Canefield
Laudat
La Plaine
ROSEAU
Delices
Pointe Mulatre
Geneva
Soufriere
Estate
Village
Town
Roads built
before 1953
since 1954
Main roads
Secondary roads
Scale
1 0 1 2 3 4
Miles
Sources :
J.A.N Burra, A Report upon Land Administration in Dominica, 1953, and Directorate of Overseas Surveys, 1963.

Map 17 Roads

Plate 11. The coastal roads are costly to maintain. In Pointe Michel the road has been subjected to erosion by the sea.

Plate 12. The roads along the coast, as well as in the interior, are subject to frequent landslides.

Plate 13. Dominica's roads are often narrow and heavy rains contribute to the formation of potholes.

Plate 14. Bananas bruise easily while being transported over the potholed roads leading to Roseau. To prevent bruising bananas are bundled in dry leaves and the interior walls of the trucks are padded.

There has been considerable development of the road system in Dominica during the last 20 years, but although planning began in 1949, much of the actual extension has taken place in the last decade. The road system has been developed from 100 miles of oiled surface and 250 miles of secondary roads in 1956 to 175 miles of Class I roads and 193 miles of Class II roads in 1965[3] (Map 17). A transinsular road connecting Deux Branches with Riversdale was completed in 1958. The windward coast at Castle Bruce and Rosalie was joined up with the transinsular road at Pont Cassé and the windward coast road itself was extended southwards from Castle Bruce to Petite Soufrière and from Rosalie to La Plaine. In the northern part of the island a road was built from Blenheim to Peineville. The leeward coast road system was extended to Soufrière in the south and an important extension, the building of the Layou Valley road from Pont Cassé to Hillsborough, was added more recently. Because the older part of the transinsular road from Canefield to Pont Cassé is in poor repair (there are numerous potholes) much of the transinsular traffic now uses this longer Layou Valley road.

The road network is still being extended; southwards from Delices to Pointe Mulatre; and northwards from Batali towards Portsmouth. It seems unlikely, however, that the growth of the last ten years will be repeated. Bartell noted that "the prosperity that an expanded road system promotes contributes to the more rapid depreciation of existing roads through heavier use..."[4] Heavy rains are also responsible for a lot of damage to the roads. Landslides frequently block or sweep away sections of new roads and the heavy rain contributes to the formation of potholes. It has become costly

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[3]These figures are based on the Colonial Office Reports on Dominica for 1956 and 1965.

[4]Bartell, op. cit., p. 9.

to repair and maintain the existing road system and the budget for road construction in the island economy is reaching its limit. It has been proposed that the increase in agricultural production be brought about by the development of those lands presently served by the existing road system.[5]

Transport Costs of Estate Produce

The differences in transportation costs for each of the major crops grown on estates varied considerably throughout the island. A uniform unit of measurement of 100 lbs. was used in determining transport costs so that comparisons could be made between the transport costs for several crops. When the average transport cost per mile was calculated for each crop it was found that the cost of transporting bananas and coconuts was considerably higher than for any of the three citrus crops. In fact there was little difference in the average rate per mile per 100 lbs. of limes, grapefruit and oranges. On four estates which produced all five crops and transported them to Roseau, the transport rates per mile were highest for bananas, coconuts, limes, grapefruit and oranges in that order.

Transport of Bananas

Banana growers in Dominica export their produce to Britain through the Dominica Banana Growers' Association and Geest Industries Ltd. All bananas are first sold to the Association which then sells them to Geest Industries. The Geest banana boats call at Roseau and Portsmouth on Thursdays and Fridays respectively. These boats have already collected bananas from the other Windward Islands and Dominica is their last port of call in completing their cargo for Britain. There are no adequate docking facilities

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[5]See L.G. Campbell in The Development of the Natural Resources of Dominica, p. 3, and J.R. Sargent et al, Report of the Tripartite Economic Survey of the Eastern Caribbean, H.M.S.O., London, 1967, p. 225.

in Dominica, the bananas being taken out on lighters to the boats lying off-shore. The small wharves where the lighters are loaded are located at the reception stations of Fond Colet, north of Roseau, and Long House to the south of Portsmouth.

The reception stations are large sheds where growers bring their bananas every Thursday or Friday to be weighed and loaded onto the lighters. The Fond Colet station serves the southern half of the island and Long House caters for growers in the north (Map 18). These reception stations are operated by the Banana Growers' Association and Geest Industries although the operational expenses are borne by Geest. The growers are paid by the Association according to the weight of the bananas and this price varies from 4.0¢ per lb. in winter to 4.7¢ per lb. in summer (British West Indian currency).

Growers who produce small quantities of bananas, and for whom it is uneconomical to hire a truck, may sell their bananas at "buying stations" scattered throughout the island and maintained by the Association. A charge of 68¢ per lb. in the southern district and 80¢ per lb. in the northern district is levied and covers transport costs from the buying stations to the reception stations as well as the costs of maintaining the buying station. The transport of bananas from the buying stations is usually carried out by the Association's own trucks but other trucks are often hired as well. The rate paid to hired truckers is shown in Table VI.

The buying stations are used only by those who produce small quantities of bananas and the majority of estate producers send their bananas directly to the reception stations at Fond Colet or Long House. Two smaller reception stations at Batali and Salisbury serve the central leeward coast and are maintained by the Banana Growers' Association. However, the quantities of bananas handled at these reception stations are very small and the

TABLE VI - TRANSPORTATION RATES OF BANANAS FROM BUYING STATIONS

Buying Station	Distance to Fond Colet (miles)	Rate per 100 lbs. of bananas (cents)	Rate per mile (cents)
Southern District:			
Castle Bruce I	27	50	1.85
Castle Bruce II	27	50	1.85
Castle Bruce III	27	50	1.85
Giraudel	7	21	3.00
Copt Hall	3	17	5.66
Good Hope	30	50	1.66
La Plaine I	32	55	1.72
La Plaine II	32	55	1.72
Colihaut	22	24	1.09
Fond Colet	-	13	
	Distance to Long House (miles)		
Northern District:			
Deux Branches I	28	56	2.00
Deux Branches II	28	56	2.00
Concord I	28	56	2.00
Concord II	28	56	2.00
Swingbridge	24	48	2.00
Crapaud Hall	27	54	2.00
Sam's Gutter	21	42	2.00
Weirs	21	42	2.00
Marigot	21	42	2.00
Strathill	21	42	2.00
Glanvillia	-	13	-
Point Ronde and Syndicate	10	40	4.00

Source: Dominica Banana Growers' Association, Roseau, 1967.

bananas are taken by lighter along the coast to either Fond Colet or Long House depending on the space available on the banana boats.

The majority of estate owners have their own trucks for taking their bananas to the ports. It is difficult to assess transport costs when estate trucks are used because they provide various functions apart from the trans-

Map 18 Banana buying stations
NORTHERN DISTRICT
SOUTHERN DISTRICT
Long House
Glanvillia
Pointe Ronde
Syndicate
Colihaut
Marigot
Weirs
Sam's Gutter
Swingbridge
Crapaud Hall
Concord
Deux Branches
Salisbury
Castle Bruce
Good Hope
La Plaine
Fond Colet
Copt Hall
Roseau
Giraudel
Buying stations
Banana wharf
Scale
1 0 1 2 3 4
Miles
Source : Dominica Banana Growers' Association.

Plate 15. The reception station at Fond Colet is the scene of great activity every Thursday when the banana boat calls, regardless of the weather.

Plate 16. The bananas are carried from the large shed to the wharf where they are loaded onto lighters and taken out to the larger banana boats.

port of produce. Almost all of the estates, however, have occasion to hire other trucks to help with transporting and a transport rate can be more easily assessed from the prices charged by the hired trucks.

In transporting bananas the hired truckers charge a rate "per stem" rather than a rate "per lb." This is presumably because terminal handling costs of loading and unloading have a large share in the overall transport costs. Although the rate per stem generally increases with distance from either Roseau or Portsmouth (on the eastern coast the rate is 12¢ and 14¢ per stem and in the vicinity of Roseau it falls to less than 10¢ per stem) there are more significant differences in the rates within smaller areas than between different parts of the island. In the valleys behind Roseau there is a considerable range from 2¢ per stem to over 20¢ per stem and the increase is not proportional to distance. Some of these estates are served by poor second class roads and because of this the rates for hired trucks are higher. These transport rates, therefore, are as much a measure of the condition of the road and of isolation from a good motorable road as they are a measure of transport distance from the ports. There are also a few estates which have much higher transport costs per stem than neighbouring estates, e.g. those in the Morne aux Diables peninsula. This is due to the absence of a motorable road into the estates and the bananas and other produce have to be "headed out" or taken by donkey to the road where it is picked up by trucks. These estates have an additional transportation cost which adds considerably to the overall transport costs.

The rate per stem measure does not provide a convenient measure for the comparison of banana transport rates with the transport rates for other agricultural produce. It was therefore decided to calculate the cost of transporting 100 lbs. weight of bananas so that such a comparison could be

made with the cost of transporting 100 lbs. weight of citrus or coconuts. Furthermore, the rate per stem does not give a true reflection of the actual transport costs for each estate as the average weight per stem varies from one estate to another and the grower is paid according to the weight of his bananas. For example, it is cheaper to transport four stems weighing 25 lbs. than five stems weighing 20 lbs. although the weight and price paid for each would be the same. A theoretical transport rate has therefore been calculated assuming that the average weight per stem throughout the island is 27.5 lbs.[6]

TABLE VII - AVERAGE TRANSPORT COSTS FOR BANANAS GROWN ON ESTATES

Location	Miles to Port	Average transport cost per 100 lbs. (cents)	Average transport cost per mile (cents)
Vieille Case	10	44	4.40
Calibishie	12	22	1.83
Wesley	19	38	2.00
Marigot	20	48	2.40
Castle Bruce	28	45	1.61
Rosalie	27	50	1.85
Pont Cassé	15	36	2.40
Salisbury	13	33	2.54
St. Joseph	11	30	2.73
Mahaut	6	30	5.00
Trafalgar	3	30	10.00
Giraudel	6	22	3.67
Bellevue-Chopin	7	35	5.00
Grand Bay	10	38	3.80
Soufrière	7	34	4.86
Pointe Michel	4	20	5.00

The figures in Table VII have been calculated for the average costs of transporting bananas to Roseau and Portsmouth from different parts of the island. The figures were derived from the average cost of transporting

[6]Based on the average weight per stem of bananas in Dominica in 1966 which is quoted in the Dominica Banana Growers' Association Annual Report for 1966.

bananas from estates which are located close to the villages and locations mentioned. These figures did not take into account those estates which had very high transport costs resulting from head carriage or animal transport. It is noted that the rate per 100 lbs. per mile increases in the vicinity of Roseau. This is due to the fact that terminal handling costs occupy a proportionally larger part of the overall transport costs for these estates located near the port.

Transport of Limes

Small quantities of green limes are exported each year to Barbados and the French islands of Guadeloupe and Martinique. These limes are bought by hucksters (i.e. agents who buy the produce from the grower) either in the Roseau market or on the estates where they are grown. The majority of limes grown in Dominica, however, are sold for the extraction of lime oil and juice either to L. Rose and Co. or A.C. Shillingford and Co. in Roseau. These two companies have factories in Roseau and they export the oil and juice to Britain.

Roseau is the port outlet for all lime products, both for green limes and fresh limes for the inter-island market and for lime extracts for Britain. The lime growers may sell their crop on the estate or in Roseau. The crop is generally transported by truck to Roseau although small quantities from the northern part of the island are sent by lighter from Portsmouth to Roseau. If the estate owners and managers sell green limes (i.e. young limes used in making citron) to hucksters for the inter-island market the huckster usually buys the limes on the estate and he arranges for transporting them to Roseau. On the other hand, producers who sell to the factories in Roseau may arrange to have one of the company trucks call at the estate and collect the limes. The companies also have a number of agents scattered throughout the island who buy the limes from the grower and the agent is responsible for trans-

porting the produce to the factory. The agents are often small shop-keepers who have contact with the small growers and the transporting is usually kept within the family, i.e. the limes may be carried on a truck belonging to the agent's brother or other member of the family.

The majority of growers sell their limes in Roseau and are responsible for transporting them. Green limes may be sold to hucksters in the Roseau market and the others are sold directly to the factories. When the limes are transported by the grower to the lime factories in Roseau, estate trucks are often used. However, from time to time hired trucks are also used when the crop is ready and estate transport cannot handle the volume to be transported.

The price received for green limes is considerably higher than that received for limes sold to the factories in Roseau. The price fluctuates according to the markets in Barbados and the French islands, but it ranges from $10 to $25 per barrel. One barrel of limes is equivalent to two and a half crates of limes and weighs approximately 70 lbs. The price paid for a barrel of limes in Roseau at the factory was $7 in 1967. However, the price paid by an agent to the grower on the estate is lower. This price is struck by the agent who tries to buy the limes as cheaply as possible.

The transportation rates for limes are difficult to assess because of the variety of ways in which limes are sold and transported. The difference between the price paid by an agent for a barrel of limes and the price which would have been received at the factory might be considered as the transport cost per barrel (although this includes the agent's profit). When the grower sells to a huckster, however, he has no way of knowing how much his transport costs would have been. When company trucks collect limes on the estate, they charge a fairly uniform rate of 40¢ to 50¢ per barrel, regardless of the distance from Roseau.

When the grower uses his own truck to take the limes to the factory or the market in Roseau, it is difficult to assess the actual transportation costs unless the truck is used exclusively for transporting limes. This situation never arises. One of the companies, however, makes a transport allowance for those growers who transport their own limes to the factory. This allowance corresponds closely to the cost the grower might have paid to a hired trucker and varies from 40¢ per barrel in the northern part of the island to 20¢ along the windward coast and less than 10¢ per barrel in the vicinity of Roseau. Estates which have higher transport costs because of head carriage are paid a correspondingly higher allowance by the company in Roseau.

When trucks are hired to transport limes to Roseau a somewhat more definite rate can be calculated. If a trucker charges $20 per load and a full load is made up of 40 crates then the average rate per crate would be 50¢ per crate. A difficulty with this measure is that the grower seldom has enough crates to make up a full load and the trucker charges for a full load regardless of the amount actually carried. So this figure represents the minimum transportation rate per crate. More often than not the actual transportation cost per crate to the grower would be much higher than this figure. This difficulty in estimating the transportation rate for limes was also encountered in estimating the rates for grapefruit and oranges.

Assuming that the average weight per crate for limes was 80 lbs., the cost of transporting 100 lbs. weight of limes was calculated and shown on Table VIII. This transportation cost varies considerably throughout the study area. In the northern part of the island the cost is approximately 50¢ and in the southwest, near Roseau, the figure varies from 9¢ to 13¢ for transporting 100 lbs. of limes. Several exceptions occur on estates in the valleys to the east and south of Roseau where costs are much higher than this.

TABLE VIII - AVERAGE TRANSPORT COSTS FOR LIMES GROWN ON ESTATES

Location	Miles to Roseau	Average transport costs per 100 lbs. of limes (cents)	Average transport cost per mile (cents)
Vieille Case	52	50	0.96
Calibishie	46	50	1.09
Wesley	39	50	1.28
Marigot	35	48	1.37
Castle Bruce	28	31	1.11
Rosalie	27	25	0.93
Pont Cassé*	15		
Salisbury	13	21	1.62
St. Joseph	11	20	1.82
Mahaut	6	13	2.17
Trafalgar	3	11	3.67
Giraudel	6	9	1.50
Bellevue-Chopin	7	10	1.43
Grand Bay	10	20	2.00
Soufrière	7	15	2.14
Pointe Michel	4	15	3.75

*None of the nearby estates produce limes.

The higher cost is attributable to the fact that the produce has to be taken by head carriage or donkey from the estate to the main road where it is collected by trucks. The transport costs for all produce from these estates is higher because of this handicap.

Transport of Grapefruit

It has already been noted that almost all the grapefruit grown for export in Dominica is sent to Britain and only small quantities are sold to hucksters in Roseau for the inter-island market. The fruit sent to Britain is taken to the Agricultural Marketing Board depot in Roseau for packing and the crates are then taken by lighter from the wharf at Fond Colet out to the Geest boats for transport to Britain. The grower cannot be assured of a price for his fruit until it is actually sold on the London market and

if the fruit arrives on the market when prices are low, the grower is faced with a loss because he must also meet the costs of packing, lighterage and transport, including overseas transport.

The price received by the grower will depend upon market conditions in London at the time his fruit arrives. In early September the average price rises from $7 to over $11 per crate but these prices last only until the arrival of South African grapefruit. When the South African fruit arrives prices drop to less than $3 per crate and some Dominican producers receive debit notes because their fruit arrived too late and the market price did not even cover overseas transportation costs which is $2.68 B.W.I. from Roseau to London.[7] Because of the unreliable nature of the market, the production of grapefruit is a hazardous venture. Nonetheless, estate owners seem undeterred, and new areas are still being planted in grapefruit.

All grapefruit being exported is transported by truck from the estates to Roseau. The bulk of the fruit matures in August and September so that estate trucks cannot always handle the volume of fruit to be taken to the port and other trucks have to be hired. Hired truckers charge the grower a rate per load regardless of whether the grower has a full load or not. This rate was used to calculate the rate of transporting a crate of grapefruit to the port. As in the case of transporting limes it is to be noted that this figure represents the minimum transport cost and the actual transport cost to the grower is often higher than this.

If it is assumed that the average weight per crate of grapefruit was 80 lbs. the cost of transporting 100 lbs. of grapefruit from various parts of the island was calculated and is shown in Table IX. The variations in

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[7] J.H.C. Grell, Personal communication, 1968.

TABLE IX - AVERAGE TRANSPORT COSTS FOR GRAPEFRUIT GROWN ON ESTATES

Location	Miles to Roseau	Average transport costs per 100 lbs. (cents)	Average transport cost per mile (cents)
Vieille Case*	52		
Calibishie*	46		
Wesley	39	40	1.02
Marigot	35	40	1.14
Castle Bruce*	28		
Rosalie*	27		
Pont Cassé	15	20	1.33
Salisbury*	13		
St. Joseph	11	18	1.64
Mahaut	6	13	2.17
Trafalgar	3	14	4.67
Giraudel	6	15	2.50
Bellevue-Chopin	7	20	2.86
Grand Bay*	10		
Soufrière	7	30	4.29
Pointe Michel	4	20	5.00

*None of the nearby estates produce grapefruit

the costs of transporting 100 lbs. of grapefruit shows a general increase with distance from Roseau. In the vicinity of the port the cost ranges from 13¢ to 15¢. The exceptions already noted in the pattern for lime transportation costs are also to be found in the pattern of transportation costs for grapefruit. When either head carriage or donkey have to be used for transporting grapefruit the overall costs are high. One estate produced a small quantity of fruit and because all of the fruit had not matured at the one time the hired truck was required to make two trips to bring the crop down to Roseau. The number of crates on both trips was very small and so the transport rate per crate was very high. The grapefruit producing estates farthest from Roseau by road are located on the north leeward coast. The fruit must be taken by road through Portsmouth and then eastwards and

southwards along the transinsular road because there is no direct road connection with Roseau along the west coast. The total length of the journey by road is 65 miles, although only 16 miles as the crow flies, and so the cost of transporting 100 lbs. of grapefruit is 86¢ per 100 lbs.

Transport of Oranges

The demand for Dominican oranges on the British market has fallen off since 1950 and most of the crop which is exported is sold in the inter-island market. This is not a lucrative market and the demand is limited. As a result, market prices are low and much of the Dominican orange crop is wasted on estates through lack of demand and poor prices. The price received by growers varies considerably because there is no fixed market price. The price which is received is usually agreed upon by the estate owner or manager and the huckster. Of the estates surveyed, the average price received per 100 oranges was $3.50 and for a crate of 80 oranges the price was $2.80. All oranges exported from Dominica pass through the port of Roseau.

The variations in the transportation costs were found to be similar to the variations in the costs of transporting 100 lbs. of grapefruit. The average weight of a crate of grapefruit was assumed to be 70 lbs. Since almost all of the estates which produce oranges also grow grapefruit and the size of a crate of grapefruit is the same as a crate of oranges, the transport rate per crate for each is very similar. However, because the weight of a crate of oranges is less than the weight of a crate of grapefruit the cost of transporting 100 lbs. of oranges is higher than for grapefruit.

TABLE X - AVERAGE TRANSPORT COSTS FOR ORANGES GROWN ON ESTATES

Location	Miles to Roseau	Average transport costs per 100 lbs. (cents)	Average transport costs per mile (cents)
Vieille Case*	52		
Calibishie*	46		
Wesley*	39		
Marigot	35	43	1.23
Castle Bruce*	28		
Rosalie*	27		
Pont Cassé	15	20	1.33
Salisbury	13		
St. Joseph	11	19	1.73
Mahaut	6	14	2.33
Trafalgar	3	16	5.33
Giraudel	6	16	2.67
Bellevue-Chopin	7	25	3.57
Grand Bay*	10		
Soufrière	7	34	4.86
Pointe Michel	4	24	6.00

* None of the nearby estates produce oranges

Transport of Coconuts and Copra

In the past much of Dominica's export coconut crop was exported to Barbados where they form a raw material for the manufacture of margarine. The exports were sent both in the form of copra and as loose coconuts. In the northern part of the island coconuts and copra used to be exported through Portsmouth and in the southern half of the study area they were exported from Roseau.

Today a few estates in the south still send coconuts to Roseau for conversion to copra, which in turn is exported to Barbados (Map 19). Whole coconuts are also sold to the Agricultural Marketing Board in Roseau for export to Britain and the United States of America. Most of the copra produced on estates in Dominica today is sent to the new Dominica Coconut Products Factory at Belfast Estate. This factory produces vegetable oils

Plate 17. Geest Industries box a few of the bananas which are exported to Britain, on their estate at Woodford Hill.

Plate 18. Most of the copra produced on estates is now sent to the Dominica Coconut Products factory at Belfast Estate.

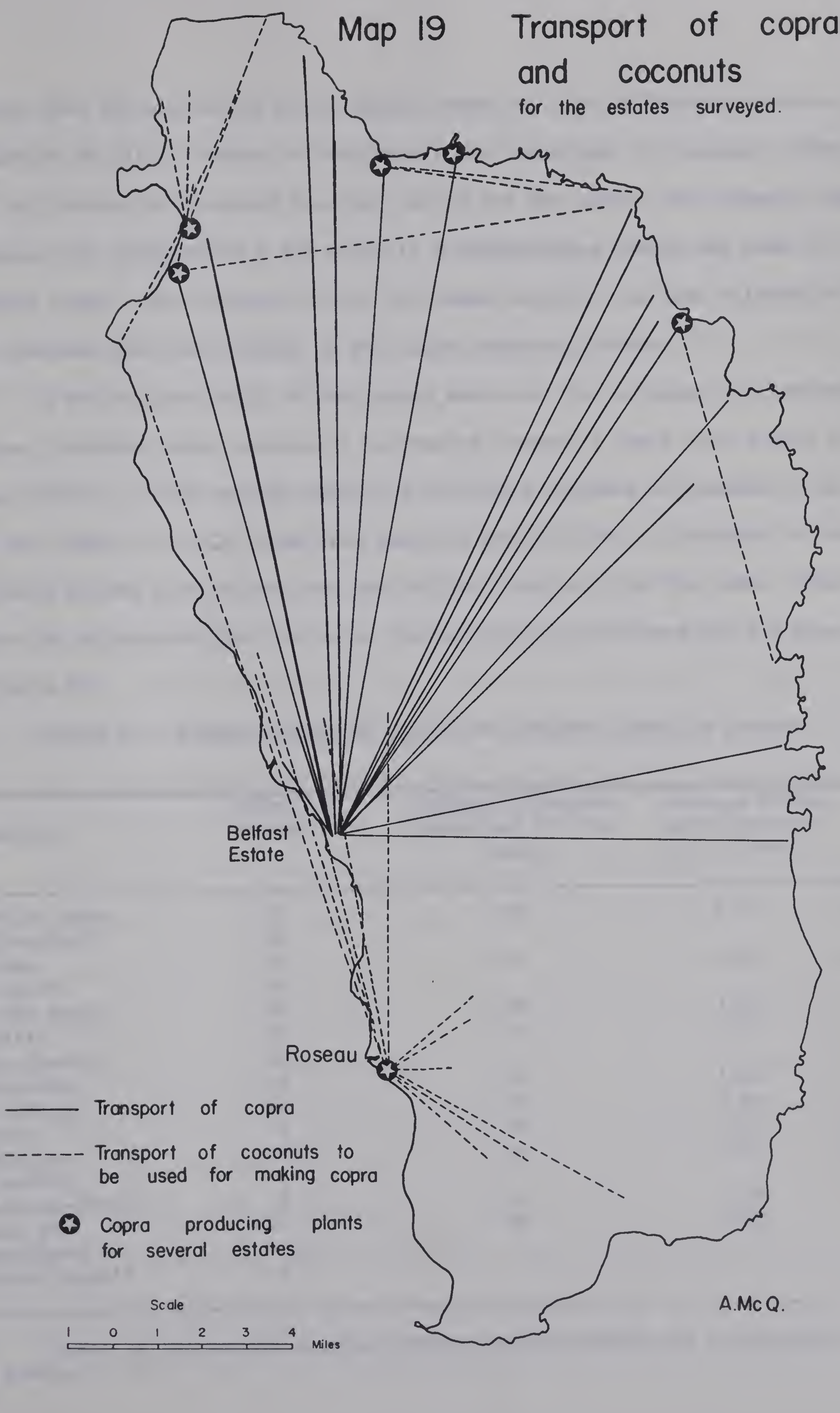
and soap. Some of this oil is exported, but the bulk of the oil is used locally to replace the edible oil formerly imported from Barbados. It is expected that a sizeable export trade in oil will develop in due course.

In the northern part of the island where there are several groups of estates under the same ownership, coconuts are taken by truck from the smaller estates to the larger ones for processing into copra (Map 19). In the Morne aux Diables peninsula several coconut growers sell their crop to agents who in turn sell it to one of the larger estates for making copra, and in several cases the small coconut producers sell their crop directly to the larger estates. The copra is then collected from the large estates and transported to the factory free of charge to the grower.

In the southern half of the island coconut growing is on a much smaller basis and there is no copra manufacture at all. The coconuts are transported by truck to Roseau where they may be sold at the Agricultural Marketing Depot for export to Barbados or they may be sold for copra manufacture at a plant in Roseau. The copra produced in Roseau is also exported.

The price received for coconuts in Roseau varied from $6.00 per 100 at the Agricultural Marketing Board Depot to $3.00 per 100 at a copra producing factory in the town. The Dominica Coconut Products Factory at Belfast Estate paid $285 per ton of copra delivered to estates. Since 4,600 coconuts, approximately, are required to produce one ton of copra the average price received for coconuts used for copra manufacture came to $6.00 per 100. In the Morne aux Diables peninsula, where agents and dealers buy many of the coconuts, the average price received was lower and varied from $4.00 to $5.00 per 100. However, when these coconuts were sold again to the copra producers the price received approximated $6.00 per 100.

Since the transportation pattern in the northern part of the island is



Map 19 Transport of copra and coconuts for the estates surveyed.

unlike that for any of the other estate crops (in that all coconuts are not assembled in either Roseau or Portsmouth) the variations in transport costs are not related to distance from any one of the two ports. For example, some coconuts are transported a few miles to a neighbouring estate and used to produce copra. The transport costs for these coconuts are thus related to the distance they are trucked to the copra producing estate.

In the southern half of the island where all the coconuts are trucked to Roseau, the more usual pattern of increasing transport costs from Roseau is discernible. If the average weight of 40 husked coconuts is assumed to be 100 lbs. then the costs range from over 14¢ per 100 lbs. of coconuts in the vicinity of the port to over 40¢ per 100 lbs. farther from the town. These costs are calculated from the rates charged by hired truckers and are shown in Table XI.

TABLE XI - AVERAGE TRANSPORT COSTS FOR COCONUTS GROWN ON ESTATES

Location	Miles to Roseau	Average transport costs per 100 lbs. (cents)	Average transport cost per mile (cents)
Vieille Case	52	40	0.77
Calibishie*	46		
Wesley	39	40	1.03
Marigot*	35		
Castle Bruce	28	30	1.07
Rosalie	27	30	1.11
Pont Cassé*	15		
Salisbury	13	20	1.54
St. Joseph	11	18	1.64
Mahaut	6	14	2.33
Trafalgar	3	14	2.67
Giraudel*	6		
Bellevue-Chopin	7	20	2.86
Grand Bay	10	20	2.00
Soufrière*	7		
Pointe Michel*	4		

* None of the nearby estates produce coconuts which are transported to Roseau.

Copra which is produced on estates for sale to the Dominica Coconuts Products Factory is usually collected by trucks from the factory and there is no direct transport charge to the estates. The price received for copra on the estate was $285 per ton. Those producers who transported their copra to the factory were given an extra 30¢ per bag of 160 lbs. (14 bags make up one ton of copra) towards transport costs although this allowance did not cover the costs of hired transport.

Other Products

The cocoa which is produced in Dominica is exported from Roseau to Britain and Holland. However, the amount grown on estates is very small and is usually gathered from old cocoa trees, the remnants of a former period when cocoa was grown on a larger scale. These remnants of cocoa plantings are also found on small landholdings, and it is from these that much of the cocoa exported is produced. Although this is the general pattern of cocoa production there are a few of the larger estates which maintain substantial acreages in cocoa with regular replanting, e.g. at Melville Hall and Castle Bruce.

Much of the cocoa grown in the northern part of the study area is sold either directly or through agents to the Commonwealth Development Corporation. The cocoa is usually sold on the estate and the grower has no transport costs. The cocoa is sold in a "wet" condition and is dried at Melville Hall Estate before being trucked to Roseau for export to Holland. On a few estates the cocoa is dried before being sold and a higher price is received for dry cocoa. The average price received was 7¢ per lb. for wet cocoa and 25¢ per lb. for dry cocoa. Three pounds of wet cocoa are usually required to produce one pound of dry cocoa. When growers sell their cocoa to dealers on the estate a lower price is received.

In the southern half of the island most of the cocoa is sold to A.C.

Shillingford and Co. in Roseau whence it is exported to Britain. The prices received for wet and dry cocoa are similar to those in the north, i.e. 7¢ and 25¢ per lb. Most of the cocoa is sold "wet" to the factory in Roseau and is usually transported on estate trucks. It is difficult to estimate the actual transport costs of cocoa because such small quantities are being transported at any one time and the bags of cocoa are taken on the trucks with other products. The transport costs to the grower are small and for most growers they are insignificant.

Some avocado pears and mangoes are grown on a few estates and sold through the Agricultural Marketing Board in Roseau for the inter-island trade. The price received for mangoes was around $5.00 per 100 fruit and for avocadoes the price was slightly higher, ranging from $5.00 to $7.00 per 100 fruit. The average cost of transporting a crate of 80 mangoes or avocadoes was reckoned to be the same as for a crate of citrus, but the quantity being transported at one time is so small, as in the case of cocoa, that the transport costs to the grower are not significant.

The estates which collect bay leaves transport the bay oil to Roseau where it is sold and exported. The average market price for bay oil in Roseau was $7.00 per lb. (and 10 lbs. are equal to 1 gallon). There were only four estates which produced bay oil and three of these were on the south coast some eleven miles from Roseau. The other estate on the west coast was 15 miles north of the town. The average price paid for transporting the bay oil was between 4¢ and 5¢ per lb.of bay oil.

Other crops produced on estates for local sales but not for export, included sugar, coffee and ground provisions. Much of the sugar is grown on small landholdings on the western side of the island as well as on a few of the estates. The sugar is crushed on several of the estates and

used for making rum. Coffee and ground provisions are sold in Roseau for the local market. The transporting cost for this produce is not known. The small quantities are taken on the local buses and unless the amount being taken is large no costs are charged.

Comparison of Rates

In the introduction to this section dealing with the transport costs from the estate to the port for various crops, it was indicated that bananas and coconuts were generally more expensive to transport than limes, grapefruit and oranges. This estimate was based on the average transport costs for each crop on all estates. A comparison of the tables showing the average transport costs for each crop from various locations throughout the island does not seem to substantiate this observation, the reason being that in calculating the figures for the various locations in the tables, the average cost for the estates close to the location was considered. Other estates at some distance from the location were omitted. There was considerable variation in costs on these estates, particularly for the estates which required head carriage and animal transport to carry the produce out to the main road. However, the significance of the differences in transport rates, and the importance of these differences for crop production on estates, will be examined in more detail in the next chapter.

CHAPTER V

ANALYSIS AND CONCLUSION

The previous two chapters describing estate agriculture and transportation have prepared the groundwork for the focus of this study which is to determine the nature of the relationship (if any) between the accessibility of estates and their production. It has already been agreed that accessibility will be best measured in terms of transport costs. Fentem suggested that "the variety and distribution of production, as well as its volume and intensity, are largely determined by accessibility."[1] In this chapter the various aspects of "variety," "volume" and "intensity" of estate agriculture will be examined with regard to transport costs.

The historical evidence demonstrating the importance of accessibility to the location and production of estates is impressive. In the late eighteenth and much of the nineteenth centuries when water transport was required for estate produce, most of the large estates were located along the coast. The majority of the estates which developed inland did so in the vicinity of Roseau, the main port and market outlet. As the road network was expanded in the mid-twentieth century, other areas became important agriculturally and the estates in those areas expanded their production, e.g. the increased production on the large estates in the Northeast since the completion of the transinsular road. Moribund estates in the Eastern District which were without road transport facilities until a few years ago are now being revived as new roads are built in that area.

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[1] A.D. Fentem, A Commercial Geography of Dominica, Indiana University, Bloomington, Indiana, 1960, p. 8.

Moreover, some parts of the island, as in West Morne Diablotins and the extreme southern part of the Eastern District, do not have an adequate road link with Roseau and the contribution of the estates in those areas towards export agriculture is insignificant. A comparison of the map showing the present road system (Map 17) with those showing the volume of production for the main crops (Maps 11-16) clearly indicates that there is a general relationship between the distribution of agricultural production for estates and the availability of road transport facilities.

<u>Variety of Estate Production</u>

The variety of agricultural production on estates has been referred to in Chapter III. The means chosen to describe the variety of production for each estate was the crop-combination which typified each estate. It was noted that the crop combinations varied considerably from one part of the island to another. An attempt must now be made to learn if there is a relationship between the variations in crop combinations and variations in the transport costs for each crop.

The first step in this analysis is to examine the differences in transport costs from one crop to another. To do this a common unit of cost is required, and the average cost of transporting 100 lbs. weight per mile is calculated for each crop. Then a test for the significance of the differences in transport costs is required for all crops. For example, only if the difference between the cost of transporting 100 lbs. of bananas and 100 lbs. of limes is significant, may we consider the hypothesis that transport costs account for even part of the variation in banana production relative to lime production. If the differences in transport costs are not significant then we must assume that transport costs do not account for any significant part of the variation in banana production relative to limes. In Chapter IV reference was made to

the fact that the average cost of transporting 100 lbs. of produce per mile for all the estates surveyed was highest for coconuts and bananas and lower for transporting citrus (limes, grapefruit and oranges). However, a somewhat more rigorous analysis is necessary to determine if the differences in transport costs for each crop are really significant.

The method used to determine the significance of these differences is based on the method for measuring the differences of means outlined by Panofsky and Brier.[2] An example of testing the significance of the differences in transport costs for bananas and limes is used to illustrate this procedure:

(1) Obtain the differences in transport costs per 100 lbs. per mile between limes and bananas (B - L) for all estates which transport both limes and bananas.

(2) Rank the differences without regard to sign starting with the smallest. Any zero differences resulting from equal transport costs for bananas and limes are eliminated before the ranking is begun. If there are two or more differences having the same value then they are assigned a mean rank, e.g. if the 8th and 9th differences have the same value they are ranked as 8.5 and the next difference is assigned the rank 10.

(3) Then the ranks are assigned positive or negative signs according to whether the actual difference values were positive or negative. If the transport costs for bananas were higher than for limes most of the rank differences would have a positive sign. Furthermore, any "negative" ranks would be small.

(4) To determine if the differences in transport costs for bananas

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[2] H.A. Panofsky and G.W.Brier, Some Applications of Statistics to Meteorology, Pennsylvania State University, University Park, Pa., 1965, pp.64-66.

and limes are significant, the sum of the ranks having the fewest cases of the same sign is obtained. This total is then referred to Table XII which indicates the significance limits of 5 per cent and 1 per cent for the given number of estates. The lower the total figure, the more significant the differences in transport costs.

TABLE XII - SIGNIFICANCE LIMITS OF PAIRED SAMPLES BY RANK METHOD

Number of Pairs	Limiting Absolute Value of Total for 5% Limit	1% Limit
8	4	0
9	6	1
10	8	3
11	12	5
12	14	6
13	18	10
14	21	11
15	26	15
16	30	18
18	40	24
20	52	36
22	66	47
24	81	60
26	98	74
28	117	90
30	137	107

Source: See text.

Table XII is derived from the following formulae:

5% Limit: $$\frac{N\,(N+1)}{4} - 1.960\sqrt{\frac{N(N+1)(2N+1)}{24}}$$

1% Limit: $$\frac{N\,(N+1)}{4} - 2.576\sqrt{\frac{N(N+1)(2N+1)}{24}}$$

The 5 per cent and 1 per cent limits indicate the degree of the significance of the differences in transport costs of the two crops being compared. If the sum of the ranks with fewest cases of the same sign for 10 estates is 5 then the probability of the differences being due to chance is between 1 per cent and 5 per cent which is relatively high. In other words, the differences

in transport costs may be the consequence of some variable(s) operating at random. If the rank value is 11 instead of 5 then the differences in transport costs would not be significant. On the other hand, if the sum of the rank differences with fewest cases of the same sign for the 10 estates is 2 then the likelihood of the differences being significant is greater. This means that there is less than a 1 per cent probability that the differences are due to chance.

From a preliminary scan of the differences in transport costs it was not possible to ascertain if the differences were really significant. The procedure outlined above is therefore used to determine the significance of the differences of transport costs (per 100 lbs.) for each pair of crops grown on estates. The crops are taken in the order of bananas, citrus (limes, grapefruit and oranges) and coconuts as a matter of convenience throughout the study and the order refers to their importance as export commodities. The result of this test is shown in Table XIII. The sign in the "sum of

TABLE XIII - SIGNIFICANCE OF DIFFERENCES OF TRANSPORT COSTS FOR CROPS

Transport Cost Differences	Number of Estates	Sum of the ranks with fewest cases of the same sign	Limiting Absolute Value of Total for 5% Limit	1% Limit
B - L*	26	(-) 87	98	74
B - G	30	(-) 87	137	107
B - O	18	(+) 56	40	24
B - C	26	(+) 4	98	74
L - G	16	(+) 13	30	18
L - O	11	(+) 0	12	5
L - C	15	(+) 25.5	26	15
G - O	18	(+) 0	40	24
G - C	16	(+) 26.5	30	18
O - C	11	(+) 6.5	12	5

* Crops are referred to by the initial letter, B = bananas, L = limes, G = grapefruit, O = oranges, and C = coconuts.

the ranks" column indicates which crops are more costly to transport than others. When the sign is negative the crop indicated in the first column is more expensive to transport than the one in the second column, e.g. bananas, are more expensive to transport than limes. On the other hand, when the sign is positive the transport costs for the crop in the second column are higher than for the crop in the first column, e.g. oranges are more costly to transport than bananas.

By comparing the sum of the ranks (column 3 in Table XIII) with values for the 1 per cent and 5 per cent limits (columns 4 and 5) it can be seen that the differences in transport costs for bananas and oranges are not highly significant. In fact, the difference in transport costs falls outside the 5 per cent limiting value. This means that the probability of these differences being due to chance is greater than 5 per cent and so is not very significant. Because of this it cannot be assumed that the differences in transport costs account for the variety of banana and orange production on estates.

The differences in transport costs between bananas and limes, limes and coconuts, grapefruit and coconuts, and oranges and coconuts has a rank sum value between the 1 per cent and 5 per cent value limits. This means it is doubtful that the differences in transport costs between these crops are significant, the probability of their being due to chance being greater than 1 per cent but less than 5 per cent.

The test outlined above has given some indication of the probability of the differences in transport costs being due to chance. The next step is to examine the actual strength of the relationship between differences in transport costs and differences in variety of production. In order to determine if the differences account for a larger proportion of the variety

of production on estates a simple linear correlation analysis is carried out. The correlation coefficient for the analysis is given by the formula:[3]

$$r_{yx} = \frac{\overline{XY} \;.\; \overline{X}\,\overline{Y}}{\sqrt{(\bar{X}^2 - \bar{X}^2)(\bar{Y}^2 - \bar{Y}^2)}}$$

The square of the correlation coefficient (i.e. r^2_{yx}) measures the ratio of the variance of Y explained by the linear association of Y with X to the total variance of Y. The analysis attempts to explain the variance of the differences in gross return to each estate (Y) by using the differences in transport costs (X) for each pair of crops.

The analysis shows that the differences in transport costs account for little of the variation of the differences in gross return between most crops. The only significant difference is between limes and coconuts. Table XIV indicates that 29.16 per cent of the variation of the differences in gross return between these two crops can be accounted for by the differences in gross return.

TABLE XIV - CORRELATION COEFFICIENTS (r) AND PERCENTAGE VARIATION OF THE VARIETY OF ESTATE PRODUCTION ACCOUNTED FOR BY DIFFERENCES IN TRANSPORT COSTS

		Differences in gross return and differences in transport costs		Differences in percentage of total income and differences in transport costs	
	N	r	% variation	r	% variation
B - L	26	-0.19	3.61	-0.17	2.89
B - G	30	0.06	0.36	-0.36	12.96
B - O	18	-0.19	3.61	-0.23	5.29
B - C	26	-0.06	0.36	-0.12	1.44
L - G	16	-0.32	10.24	-0.21	4.41
L - O	11	-0.12	1.44	-0.10	1.00
L - C	15	-0.54	29.16	-0.31	9.61
G - O	18	-0.16	2.56	0.04	0.16
G - C	16	-0.18	3.24	-0.25	6.25
O - C	11	-0.17	2.89	-0.29	8.41

[3]H.M. Blalock, Social Statistics, McGraw-Hill, New York, 1960, p. 289.

Another method of relating the differences in transport costs to the variety of production is to correlate the differences in transport costs with the differences in percentage of the total income of the estate which is contributed by each crop. A simple linear correlation analysis, as outlined above, is used for this test and once again low correlation coefficients are obtained (Table XIV). The highest correlation coefficient was obtained for bananas and grapefruit and it was found that the difference in transport costs accounted for 12.96 per cent of the difference in percentage of the total income contributed by bananas and grapefruit.

Thus, neither the percentage of the differences in gross return nor the difference in percentage income for each crop which can be accounted for by the differences in transport costs is high, except perhaps in the case of limes and coconuts. Since transport costs account for very little of the variety of crop production measured by the differences in gross return and differences in percentage income for crops, it must be assumed that the variety of estate production is not determined by accessibility (measured in terms of transport costs) to a significant degree. At the same time a word of caution is necessary concerning the reliability of the analysis described above. The correlation analysis is carried out on the assumption that the data are distributed on a Gaussian distribution. Since the largest number of pairs of crops correlated is 30, normalcy cannot be immediately claimed for the distribution of the data. However, a test can be applied to the data to learn the extent to which it conforms to a Gaussian distribution. "The rule of thumb states that a normal distribution is an adequate approximation if Np (1-p) exceeds 9."[4] If the number of estates (N) is 30 then Np (1-p) is

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[4]This is the binomial test described by H.A. Panofsky and G.W. Brier, op. cit., p. 53.

only 7.5 and for 11 estates the result is 2.75. So for the correlations of less than 30 estates, this approximation to the Gaussian distribution decreases as the number of estates decreases. The reason for the number of estates (N) being small is due to the fact that only 30 of the estates covered by the survey grow both bananas and grapefruit and only 11 of the estates surveyed grew both limes and oranges and coconuts and oranges.

Assuming that the data are distributed normally a test of the significance of the correlation coefficients can be carried out.[5] If the value of the correlation coefficient, r, is greater than $2.6\sigma_r$ (where $\sigma_r = \frac{1}{\sqrt{(N - 2)}}$) then the probability of the correlation coefficient originating from uncorrelated data is less than 1 per cent and may be regarded as significant. Table XV indicates the degree of significance of the correlation coefficients relative to this 1 per cent significance limit. It can be seen that the probability of the correlation coefficients of the size observed originating from the influence of random variations is greater than 1 per cent. The importance

TABLE XV - SIGNIFICANCE OF CORRELATION COEFFICIENTS (r) BETWEEN VOLUME OF PRODUCTION (1) AND (2) PERCENTAGE INCOME WITH (3) DISTANCE

	N	$r_{1.3}$	$r_{2.3}$	1 per cent significance limit
B - L	26	0.19	0.17	0.52
B - G	30	0.06	0.36	0.47
B - O	18	0.19	0.23	0.65
B - C	26	0.06	0.12	0.52
L - G	16	0.32	0.21	0.68
L - O	11	0.12	0.10	0.86
L - C	15	0.54	0.31	0.73
G - O	18	0.16	0.04	0.65
G - C	16	0.18	0.25	0.68
O - C	11	0.17	0.29	0.86

[5]Panofsky and Brier, op. cit., pp. 92-93.

of the results of these tests on the correlation coefficients is that they indicate that care must be taken in drawing conclusions from the coefficients. Therefore, the failure to achieve a high degree of correlation between the variety of production on estates and transport costs may be due, partly, to the small number of estates being examined in the analysis.

Volume of Production

There seems to be a discernible relationship between the volume of production for the various crops grown on estates and distance from Roseau, the main port outlet, when volume is plotted against distance on a histogram (Figures 3,4, and 5). Much of the banana production in the southern half of the island comes from estates within 16 miles of Roseau and a considerable portion of that from the Layou Valley (Figure 3). In the northern part of the study area, most of the banana production is on estates ranging from 16 to 20 miles from Portsmouth. These estates are situated on the northeast coast.

Of the limes, grapefruit and oranges grown on estates, most come from within 8 miles of the capital. The volume of lime production is slightly higher in the 4 to 8 mile bracket (Figure 3) whereas more oranges and grapefruit are grown within 4 miles of the town than in the 4 to 8 miles distance range (Figure 4). One exception is an estate in the Layou valley which produces considerably more oranges than all of the estates within 8 miles of Roseau. Excluding this one estate it can be said that estate production of all citrus beyond 8 miles of Roseau is small and scattered.

Coconut production shows a slightly different pattern from the production pattern of citrus on estates. The tendency is towards increased production of coconuts with increasing distance from the port (Figure 5). It should be remembered that most of the coconuts are used in the production of copra which is sold to the Dominica Coconut Products Factory at Belfast

Estate some 6 miles to the north of Roseau (Map 19). Coconut production is concentrated in the northeastern part of the island, 35 miles from Roseau and 29 miles from the factory at Belfast Estate.

Such a general examination of the relationship between the volume of production and distance from the port outlets is but the first step in testing whether the volume of production for each crop is determined by accessibility. A more rigorous examination is necessary to discover if the gross return for each crop on every estate surveyed is related to the transport costs for that crop. A simple linear correlation analysis is applied to the transport costs for the various crops produced on estates and the volume of production of each crop on all estates. The unit used in measuring transport cost is cost per 100 lbs. of the crop in question. When the analysis is carried out, the volume of production of all crops on each estate is then correlated with the distance over which the crop was transported to the port. The results of these analyses are given in Table XVI.

TABLE XVI - COEFFICIENTS OF CORRELATION (r) BETWEEN (1) VOLUME OF PRODUCTION AND (2) TRANSPORT COSTS WITH (3) DISTANCE

	N	$r_{1.2}$	$r_{1.3}$	Significance value at the 1 per cent limit
Bananas	73	-0.11	0.28	0.30
Limes	42	-0.19	-0.15	0.41
Grapefruit	30	0.09	0.20	0.49
Oranges	23	-0.12	0.02	0.57
Coconuts	50	-0.13	0.15	0.37

As can be seen from the table, transport costs show a weak negative correlation with the gross return from each crop, and so they account for little of the variation in the volume of production. Similarly, correlation with distance from the port shows a low coefficient, which points to the

conclusion that distance from Roseau (and Portsmouth in the case of bananas) accounts for very little of the variation in the volume of production. The significance of the relationship is weakened further by the fact that none of the correlation coefficients are as high as the 1 per cent significance limiting value, which means that the probability of these correlation coefficients resulting from the operation of random variables is greater than 1 per cent.

Intensity of Production

Another aspect of agricultural production which is influenced by accessibility, according to Fentem, is the intensity of production. What is meant by intensity of production is not clearly stated but it may be taken to mean the scale of production (i.e. either the total number of acres cultivated on estates or the gross income for each estate) or it may also mean the return per acre of cultivated land on each estate. The first step in attempting to relate the scale of production to accessibility would be to find out if there is a discernible relationship between the volume of production on each estate for each of the crops and distance from Roseau.

A more revealing aspect of the relationship of volume and intensity of production to distance from Roseau may be obtained when the number of estates involved in producing the crops is taken into consideration. By relating the number of estates to the volume produced and shown in each column (Figures 3, 4 and 5), some indication of the scale of production is given. For example, 38 estates within 12 miles of Roseau produce 1,836 tons of bananas and the average amount produced on the estates is around 50 tons. Beyond 12 miles of Roseau there are few estates producing such small quantities of bananas and the general pattern is towards large scale production. The estates on the northeastern coast are also large scale banana growers and they too are

slightly more than 12 miles from Portsmouth, whereas the smaller banana producers are found nearer the town.

The 17 estates growing limes within 4 miles of Roseau produce only 45,000 crates of limes whereas the 9 estates in the 4 to 8 mile range produce about the same quantity of limes. More grapefruit, on the other hand, is produced on 12 estates within 4 miles of the town than is produced on the 14 estates in the 4 to 8 mile range. Likewise with oranges, a smaller number of estates within 4 miles of the port produce more fruit than the 9 estates in the 4 to 8 mile range. Generally speaking, the scale of grapefruit and orange production decreases with distance from Roseau whereas the scale of lime production is higher in the 4 to 8 mile range than elsewhere.

Coconut production shows a tendency towards an increase in the scale of production with an increase in distance from Roseau. Fourteen estates within 4 miles of the town produce 125,000 nuts, 4 estates from 4 to 8 miles from Roseau produce 283,000 nuts and the 6 estates from 8 to 12 miles from Roseau produce 466,000 nuts. Much of the coconut production in the vicinity of Roseau is for export through that port. The most important coconut estates, however, are large scale estates situated in the Northeast and the coconuts from those estates are sold as copra to the factory at Belfast Estate.

From this general examination of the distribution of scales of production there seems to be a discernible relation between the size of the estate and distance from Roseau. Moreover, it has been noted in Chapter III that many of the estates producing bananas and coconuts on the eastern and northeastern coasts are large scale units of production. The greater concentration of estates in the Southwest, nearer to Roseau, are smaller units of production. The question which may be raised now is whether these estates are large so that they benefit from large scale economies which overcome

differences in transport costs? Does distance from Roseau influence the scale of production of these estates? It would seem pertinent to test whether a relationship exists between distance from Roseau and the size or scale of production.

When a more rigorous test (using a simple linear correlation) than that of general observation outlined above is applied by correlating the total acres cultivated on the estate and the total gross income of the estate with distance from Roseau, a less impressive result is obtained. It can be seen from Table XVII that distance from Roseau accounts for very little of the variation in the gross income for each estate throughout the island. It must also be noted

TABLE XVII - CORRELATION OF SCALE OF PRODUCTION WITH DISTANCE FROM ROSEAU

Scale of production	N	r	Percentage variation accounted	1 per cent significance limit value
Total acres cultivated and distance from Roseau	92	0.31	9.6	0.27
Total gross income of each estate and distance from Roseau	92	0.11	1.2	0.27

that the probability of this correlation originating from uncorrelated data is greater than 1 per cent. A slightly more significant result is obtained from correlating the total acres cultivated on each estate with distance from Roseau. The probability of this correlation coefficient resulting from uncorrelated data is less than 1 per cent and 9.6 per cent of the variation in the number of acres cultivated on each estate can be explained by distance from Roseau.

The other measure of intensity of production is the return per acre for each crop grown on estates. A serious problem in measuring the return

per acre arises because intercropping is found on almost all estates except a few of the largest ones. This means that a farmer may cultivate a 10 acre plot with bananas and grapefruit interplanted throughout. The return from bananas alone represents only part of the total gross return from the 10 acres and so the "return per acre" measure from bananas would only be part of the total return per acre from that plot. On the other hand, no other indication of the return per acre for bananas is obtainable (providing grapefruit is ignored). So, with this reservation about the reliability of the "return per acre" measure, a simple linear correlation test is used to discover if transport costs per 100 lbs. and distance from Roseau account for much of the variation in intensity of production. The results of the test are shown in Table XVIII.

TABLE XVIII - COEFFICIENTS OF CORRELATION (r) BETWEEN RETURN PER ACRE (1) AND TRANSPORT COSTS (2) WITH DISTANCE FROM ROSEAU (3)

	N	$r_{1.2}$	$r_{1.3}$	1 per cent significance limit
Bananas	73	-0.03	0.17	0.30
Limes	42	-0.11	0.01	0.41
Grapefruit	30	0.05	0.06	0.49
Oranges	23	-0.20	-0.09	0.57
Coconuts	50	0.11	-0.04	0.37

The results of this analysis give very low correlation coefficients for both transport costs and distance from Roseau. It might be assumed, therefore, that these measures of accessibility account for very little of the variation in return per acre of crops grown on estates. It should be noted that none of the correlation coefficients approached the 1 per cent significance limit, and so the probability of all the correlations being derived from the operation of random variables is greater than 1 per cent. From observation in

the field it seems that the variables of soil ferility and slope would explain more satisfactorily the variations in intensity of production.

Conclusion

The results of the analyses carried out show that accessibility, measured either in terms of transport costs per 100 lbs. or distance from Roseau, account for very little of the variety, volume, and intensity of production on estates. A more general review of agricultural production on estates seems to indicate that these relationships might indeed exist. Maps 8, 9 and 10 showing crop combinations and the percentage of the total income from each crop on all the estates surveyed, indicated that there were recognizable patterns of production which changed with increasing distance from Roseau. Maps 11-15 demonstrated that there were variations in the volume and scale of production on estates. Smaller producing units were more often found in the Southwest, whereas the larger producing units were generally found on the eastern and northeastern coasts at a greater distance from either Roseau or Portsmouth.

However, when these aspects are correlated with transport costs and distance from the ports it is found that these measures of accessibility have little relationship to the variety, volume and intensity of production. Thus it is found that although there is a reasonable basis for Fentem's observation, it is in need of some modification when more stringent tests are applied to it. Factors such as the physical conditions of the site must also be considered when accounting for the distribution of agriculture.

Since the publication of Thünen's Der isolierte Staat in Bezeihung auf Landwirtschaft und Nationalökonomie in the late 1830's a key factor in agricultural location theory has been transportation. The method of transportation in those days was by oxcart which was both difficult and expensive. As a result high yielding and bulky goods were produced close to the market

in order to overcome the difficulty of transport. Transport costs were a critical factor in determining what the farmer would produce; these costs were a simple function of distance from the market and bulk of the commodity being transported. Transportation costs have attracted much attention in location theory, but its importance may now be changing.

It is suggested here that the pre-eminence of transport costs as a critical factor in location theory must now be modified. There is no doubt that in the past the nature of agricultural production was closely associated with facility of transportation. But improvements in transportation technology have altered the relative importance of this factor in location theory. McCarty and Lindberg noted:

> Improvements in transportation have tended to lessen the advantage of sites located near markets and have increased the advantages of locations that are favored in terms of production costs. These advantages may arise from seasonal climatic superiorities, or from a combination of fertile soil and low cost irrigation water.[6]

In other words, the physical advantages of site (slope, elevation, soils and climate) become more important factors in theories of agricultural location as the importance of transport costs recedes. In Dominica, the improvements of transportation may indeed have lessened the advantages of estates located near Roseau and enhanced the possibilities of other estates with better physical conditions which are located some distance from Roseau.

These other factors must therefore be considered in conjunction with measures of distance when accounting for the variations in estate agriculture. For example, the correlation coefficient derived from correlating one aspect of the physical site (altitude) with the total number of acres cultivated on each estate is -0.34. Moreover, when the total acres culti-

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[6] H.H. McCarty and J.B. Lindberg, Preface to Economic Geography, New Jersey, Prentice-Hall, 1966, p. 224.

vated (Z) is correlated with these factors of altitude (X) and distance from Roseau (Y) in a linear multiple correlation analysis, the multiple correlation coefficient (R) is 0.4. The formula which provides this correlation coefficient is:

$$R_{zyx} = \sqrt{\frac{r^2_{zx} + r^2_{zy} - 2r_{zx}r_{zy}r_{xy}}{1 - r^2_{xy}}}$$

The square of the correlation coefficient (i.e. R^2_{zyx}) measures the percentage of the total variance of Z accounted for by the variation of X and Y.[7] To determine if the multiple correlation coefficient of 0.40 is significant the analysis of variance technique can be used as shown in Table XIX.[8] In this

TABLE XIX - ANALYSIS OF VARIANCE SIGNIFICANCE TEST OF THE MULTIPLE CORRELATION COEFFICIENT

Source	Sum of Squares	df	Mean Squares	F
Total	1	N - 1		
Regression equation	R^2	p	$\frac{R^2}{p}$	$\frac{R^2(N - 1 - p)}{(1 - R^2)\ p}$
Residual	$1 - R^2$	N - 1 - p	$\frac{1 - R^2}{N - 1 - p}$	

table p is the number of independent variables. In this case there are two; one is altitude and the other is distance from Roseau. N is the number of sets of observations (i.e. 85 estates); R is the multiple correlation co-

[7]Blalock, <u>op. cit.</u>, pp. 346-350.

[8]Panofsky and Brier, <u>op. cit.</u>, p. 113.

efficient, and F is the ratio of the mean squares. By referring the F value to the 1 per cent and 5 per cent significance limiting values provided in tables it is found that the F value for the 85 estates should be greater than 3.11 to be significant at the 5 per cent significance limit and greater than 4.88 to be significant at the 1 per cent limit.[9] The actual F value derived from the 85 estates by the procedure described in Table XIX is 8.34. This means that the multiple correlation coefficient is significant and the probability of it originating from the operation of random variables is considerably less than 1 per cent.

Altitude is perhaps not the most important of the factors of physical site. If measures of the other factors such as slope, soils and microclimate were available, it is probable that more significant results would be obtained. The reason for using this variable, in conjunction with distance from Roseau in accounting for the variation in total acres cultivated on estates, is simply to illustrate that, when factors representing the physical site are introduced, more significant results are obtained. Any attempt to explain the variation in variety, volume and intensity of agricultural production on estates must also consider these variables of soil, slope and altitude, as well as other factors such as the condition of world markets. The factors of accessibility, distance and transport costs, by themselves, account for very little of the variation of agricultural production on estates.

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[9] Ibid., pp. 72-76.

BIBLIOGRAPHY

Atwood, T. A History of the Island of Dominica, J. Johnson, London, 1791, 285 pp.

Bartell, E. National Income Statistics, Dominica 1961-1964, Institute of Social and Economic Research, Barbados, University of the West Indies, 1965, 25 pp.

Beard, J.S. The Natural Vegetation of the Windward and Leeward Islands, Clarendon Press, Oxford, 1949, 192 pp.

Beckmann, M. "Some Reflections on Lösch's Theory of Location," Papers and Proceedings of the Regional Science Association, Vol. 1, 1955, pp. N1-N9.

Birge, W.S. In Old Roseau (1900), I.H. Blanchard, New York, 1900, 105 pp.

Blalock, H.M. Social Statistics, McGraw-Hill Co. Inc., New York, 1960, 465 pp.

Blaut, J.M. "Microgeographic Sampling: A Quantitative Approach to Regional Agricultural Geography," Econ. Geogr., Vol. 35, No. 1, 1959, pp. 79-88.

Bryan Edwards Press. The Old Plantation System in the British Caribbean, Bryan Edwards Press, London, n.d., 81 pp.

Burra, J.A.N. A Report Upon Land Administration in Dominica, Roseau (mimeographed), 1949.

Byers, J. References to the plan of the island of Dominica, as surveyed from the year 1765 to 1773..., S. Hooper, London, 1777.

Campbell, L.G. "Production Methods in West Indies Agriculture," Caribbean Quarterly, Vol. 8, No. 2, 1962, pp. 94-104.

__________. The Development of Natural Resources in Dominica, University of the West Indies, St. Augustine, Trinidad, 1965, 34 pp.

Caribbean Commission, General Secretariat. Citrus, Port-of-Spain, Trinidad, 1956, 66 pp.

Caves, R.E. and R.H. Holton. The Canadian Economy, Prospect and Retrospect, Harvard University Press, Cambridge, Mass., 1961, 676 pp.

Chisholm, M. Geography and Economics, G. Bell and Sons Ltd., London, 1960, 230 pp.

__________. Rural Settlement and Land Use, Hutchinson University Library, London, 1962, 207 pp.

Clarke, W.C. Notes on the Geography and History of Dominica, Department of Geography, U. of California, Berkeley, 1962.

Coleridge, H.N. Six Months in the West Indies in 1825, Ward, Lock and Co., London, 1832, 311 pp.

Commonwealth Economic Commission. Fruit, H.M.S.O., London, 1964, 231 pp.

Coulter, J.K. "Soil and Land Use Problems in the West Indies," World Crops, Vol. 15, 1963, pp. 349-354.

Dicken, S.N. Economic Geography, D.C. Heath and Co., Boston, 1955, 569 pp.

Dorival, McM., Dominica Banana Growers' Association, Personal communication,1967.

Dumont, R. Types of Rural Economy, Methuen, London, 1957, 555 pp.

Dunn, E.S. "The Equilibrium of Land-Use Patterns in Agriculture," Southern Economic Journal, Vol. 21 (1954), pp. 173-187.

________. "The Market Potential Concept and the Analysis of Location," Regional Science Assoc., Papers and Proceedings, Vol. 2, 1956, pp. 183-194.

Dupigny, C.J.L. Personal communication, 1968.

Dziewonski, K. "A New Approach to Theory and Empirical Analysis of Location," Regional Science Assoc., Papers and Proceedings, Vol. 16, 1966, pp.17-25.

Edwards, B. The History, Civil and Commercial, of the British West Indies, G. and W.B. Whittaker, London, 1819.

El-Kammash, M.M. "On the Measurement of Economic Development Using Scalogram Analysis," Regional Science Assoc., Papers and Proceedings, Vol. 11, 1963, pp. 309-334.

Fentem, A.D. Commercial Geography of Dominica, Indiana University, Bloomington, Indiana, 1960, 18 pp.

__________. The Historical Geography of a Tropical Economy - Dominica, T.W.I., Bulletin of the Illinois Geographical Society, II (1960), pp. 4-15.

Finkel, H.J. "Patterns of Land Tenure in the Leeward and Windward Islands and Their Relevance to Problems of Agricultural Development in the West Indies," Econ. Geogr., Vol.40,1964,pp. 163-173.

__________. Report on Agricultural Development in Dominica, St. Kitts, Nevis and St. Lucia, with special reference to the utilization of land and water, Institute of Social and Economic Research, U. of West Indies, Jamaica, 1962, 33 pp.

Garrison, W.L. and D.F. Marble. "The Spatial Structure of Agricultural Activities," Annals, Assoc. of American Geographers, Vol. 47, 1957, pp. 137-144.

Great Britain, Colonial Office. Annual Report, Antigua, 1963 and 1964, H.M.S.O., London, 1966, 61 pp.

______________. Annual Report, Dominica, 1955 and 1956, H.M.S.O., London, 1958, 62 pp.

Great Britain, Colonial Office. Annual Report, Dominica, 1957 and 1958, H.M.S.O., London, 1960, 62 pp.

__________. Annual Report, Dominica, 1959 and 1960, H.M.S.O., London, 1962, 62 pp.

__________. Annual Report, Dominica, 1961 and 1962, H.M.S.O., London, 1965, 67 pp.

__________. Annual Report, Dominica, 1963, 1964 and 1965, H.M.S.O., London, 1967, 76 pp.

__________. Annual Report, Grenada, 1963 and 1964, H.M.S.O., London, 1966, 56 pp.

__________. Annual Report, Montserrat, 1963 and 1964, H.M.S.O., London, 1966, 33 pp.

__________. Annual Report, St. Lucia, 1963 and 1964, H.M.S.O., London, 1966, 58 pp.

__________. Annual Report, St. Vincent, 1962 and 1963, H.M.S.O., London, 1966, 72 pp.

Great Britain, Royal Commission. Dominica, Economic Conditions, Eyre and Spottiswoode, London, 1894, 204 pp.

Gregor, H.F. "The Changing Plantation," Annals, Assoc. of American Geographers, Vol. 55, No. 2, 1965, pp. 221-238.

Grell, J.H.C. Personal communication, 1968.

Grieve, S. Notes Upon the Island of Dominica, A. and C. Black, London, 1906, 126 pp.

Grotewold, A. "Von Thünen in Retrospect," Econ. Geogr., Vol. 34 (1959), pp. 346-355.

Gurney, J.J. Familiar letters to Henry Clay of Kentucky, describing a winter in the West Indies, Mahlon Day and Co., New York, 1840, 280 pp.

Hardy, F. "The Soils of Dominica, Their Genesis and Fertility," West Indian Bulletin, XIX (1931), pp. 86-123.

Hardy, F. and J.S. Beard, Soil Formation in the British Caribbean Volcanic Islands, P.R. Soil Conference, 1950.

Hardy, F. and G. Rodrigues, "Soil Genesis from Fragmented Volcanic Rocks in the Lesser Antilles," Proceedings of the Soil Science Society of America, Vol. 6, 1941, pp. 47-51.

Harrison, L.C. "Dominica - A Wet Tropical Human Habitat," Econ. Geogr., Vol. 11 (1935), pp. 62-76.

Hassler, J.B. "An Appraisal of Spatial Studies Related to Agriculture," Journ. of Farm Economics, Vol. 46, Part II, 1964, pp. 1380-1386.

Henderson, J.M. "The Utilization of Agricultural Land," Regional Science Assoc., Papers and Proceedings, Vol. 3, 1957, pp. 99-114.

Higgins, B. Economic Development, Problems, Principles and Policies, Constable and Co., London, 1959, 803 pp.

Hodge, W.H. "The Vegetation of Dominica," Geogr. Review, Vol. 33, 1943, pp. 349-375.

Hoover, E.M. The Location of Economic Activity, McGraw-Hill, New York, 1948, 310 pp.

Institute of Social and Economic Research, An Abstract of Statistics of the Leeward Islands, Windward Islands and Barbados, Univ. of the West Indies, Barbados, 1966, 73 pp.

James, P.E. A Geography of Man, Ginn and Co., Waltham, Mass., Third Edition, 1966, 581 pp.

Johnson, B.J. "A Note on Thünen's Circles," Annals, Assoc. of American Geographers, Vol. 12, 1964, pp. 213-220.

Kadas, C. "The Impact of the Development of Transportation on the Optimal Size of Plants and on Optimum Regional Location," Regional Science Assoc., Papers and Proceedings, Vol. 12, 1964, pp. 193-201.

Kool, R. Tropical Agriculture and Economic Development, H. Veenman and Zonen, N.V., Wageningen, The Netherlands, 1960.

Lachene, R. "Networks and the Location of Economic Activities," Regional Science Assoc., Papers and Proceedings, Vol. 14, 1965, pp. 183-196.

Lang, D.M. Soil and Land-Use Surveys No. 21, Dominica, University of the West Indies, St. Augustine, Trinidad, 1967, 59 pp.

Leibenstein, H. Economic Backwardness and Economic Growth, John Wiley and Sons, Inc., New York, 1960, 295 pp.

Lösch, A. The Economics of Location (trans. by W.H. Woglom and W.F. Stolper), Yale Univ. Press, New Haven, 1954, 520 pp.

Lovell, L. A letter to a friend relative to the present state of the island of Dominica, 1818, James Robbins, London, 1818, 39 pp.

McCarty, H.H. and J.B. Lindberg, A Preface to Economic Geography, Prentice-Hall, New Jersey, 1966, 261 pp.

McIlroy, R.J. An Introduction to Tropical Cash Crops, Ibadan Univ. Press, Ibadan, 1963, 163 pp.

Melamid, A. "Some Aspects of Thünen's Model in Regional Analysis of Economic Growth," Regional Science Assoc., Papers and Proceedings, Vol. 1, 1955, pp. L2-L5.

Mighell, R.L. and J.D. Black, Interregional Competition in Agriculture, Harvard Univ. Press, Cambridge, Mass., 1951, 320 pp.

Naftel, C.O. The Agricultural Capabilities of Dominica, Colonial Reports, Misc. No. 9, Dominica, Eyre and Spottiswoode, London.

Norris, O., Statistical Office, Roseau. Personal communication, 1968.

Norton, A.V. and Comper, G.E. "'Peasant,' 'Plantation' and 'Urban' Communities in Rural Jamaica: a test of the validity of the classification," Social and Economic Studies, Vol. 15, No. 4, Dec. 1966, pp. 338-352.

Ochse, J.J. Tropical and Subtropical Agriculture, The Macmillan Co., New York, 1961, 1446 pp.

O'Loughlin, C. A Survey of Economic Potential and Capital Needs of the Leeward Islands, Windward Islands and Barbados, H.M.S.O., London, 1963, 150 pp.

__________. "Economic Problems of the Smaller West Indies Islands," Social and Economic Studies, Vol. 11, No. 1, 1962, pp. 45-56.

Orr, E.W. "A Synthesis of Theories of Location, of Transport Rates, and of Spatial Price Equilibrium," Regional Science Assoc., Papers and Proceedings, Vol. 3, 1957, pp. 61-73.

Panofsky, H.A. and G.W. Brier, Some Applications of Statistics to Meteorology, Penn State U., University Park, Pa., 1965, 223 pp.

Persaud, B. An Abstract of West Indian Banana Statistics, Institute of Social and Economic Research, Univ.of the West Indies, Barbados, 1966, 62 pp.

Philbrick, A.K. "Areal Functional Organization in Regional Geography, Regional Science Assoc., Papers and Proceedings, Vol. 3, 1957, pp. 87-98.

Popper, K.R. The Poverty of Historicism, Harper and Row, New York, 1961, 166 pp.

Reeds, L.G. "Agricultural Geography: Progress and Prospects," Cdn. Geogr., Vol. 8, No. 2, 1964, pp. 51-63.

Rubin, V. (ed.) Plantation Systems of the New World, Pan American Union, Washington, D.C., 1959, 124 pp.

Sargent, J.R. et al. Report of the Tripartite Economic Survey of the Eastern Caribbean, H.M.S.O., London, 1967, 279 pp.

Schuchert, C. Historical Geology of the Antillean-Caribbean Region, John Wiley and Sons, New York, 1935, 811 pp.

Shephard, C.Y. "The Sugar Industry of the British West Indies and British Guiana with special reference to Trinidad," Econ. Geogr., Vol. 5, 1929, pp. 149-176.

Siffleet, N.M. "The National Accounts of Dominica, 1949," Social and Economic Studies, Vol. 1, No. 3, 1953.

Smith, T.R. "Potential Contributions of Regional Science to the Field of Geography," Regional Science Assoc., Papers and Proceedings, Vol. 3, 1957, pp. 13-15.

Spencer, J.W.W. "The Geological and Physical Development of Dominica," London Geol. Society Quarterly Journ., Vol. 58, 1902, pp. 341-353.

Starkey, O.P. Commercial Geography of the Eastern British Caribbean, Indiana Univ., Dept. of Geography, Bloomington, 1961, 18 pp.

__________. "Declining Sugar Prices and Land Utilization in the British Lesser Antilles," Econ. Geogr., Vol. 18, 1942, pp. 209-214.

Sturge, J. and T. Harvey. The West Indies in 1837, Hamilton, Adams, London, 1838, 476 pp.

Symons, L. Agricultural Geography, G. Bell and Sons Ltd., London, 1967, 283 pp.

Thompson, E.T. "The Climatic Theory of the Plantation," Agricultural History, Vol. 15, 1941, pp. 49-60.

__________. "The Plantation as a Social System," in Plantation Systems of the New World, V. Rubin (ed.), Pan American Union, Social Science Monographs, Puerto Rico, 1959, pp. 29-33.

Thorne, A.P. "Economic Background of the B.W.I. Islands," in Politics and Economics in the Caribbean, T.G. Mathews (ed.), Institute of Caribbean Studies, Puerto Rico, 1966, pp. 271-284.

Tiebout, C.M. "Location Theory, Empirical Evidence and Economic Evolution," Regional Science Assoc., Papers and Proceedings, Vol. 3, 1957, pp. 74-86.

United States Dept. of Agriculture. The Agriculture and Trade of the West Indies, Foreign Agricultural Service, Washington, Jan. 1961.

Waibel, L. "The Tropical Plantation System," The Scientific Monthly, Vol. 52, 1941, pp. 156-160.

Ward, R. and C. Brooks, Climatology of the West Indies, Gebrüder Borutraeger, Berlin, 1934, 43 pp.

Weaver, J.C. "A Design for Research in the Geography of Agriculture," Prof. Geogr., Vol. 10, No. 1, 1958, pp. 2-8.

__________. "Crop-Combination Regions in the Middle West," Geogr. Review, Vol. 44, 1954, pp. 175-200.

West, R.C. and J.P. Augelli. Middle America: Its Lands and Peoples, Prentice-Hall, New Jersey, 1966, p482 pp.

Windward Island Banana Growers' Association. Banana Growers' Manual, Voice Publishing Co., Castines, St. Lucia, 1966, 13 pp.

Wrobel, A. "Regional Analysis and the Geographic Concept of Region," Regional Science Assoc., Papers and Proceedings, Vol. 8, 1962, pp. 37-41.

APPENDIX A

AGRICULTURE AND THE ECONOMY

A close examination of the Gross Domestic Product (G.D.P.) for the Windward Islands reveals that a considerable percentage of the total G.D.P. is accounted for by export agriculture (Table XX). The real importance of agriculture to the economy might not be fully apparent from these figures, but when it is realized that other sectors of the economy (e.g. manufacturing) also depend on agriculture then its real importance may be appreciated.

TABLE XX - GROSS DOMESTIC PRODUCT FOR THE WINDWARD ISLANDS, 1962

	DOMINICA	GRENADA	ST. LUCIA	ST. VINCENT
Total G.D.P. at factor cost in $B.W.I.('000)	20,182.5	28,727.3	27,675.4	25,676.4
Population	61,026	89,860	88,231	83,352
Per capita G.D.P. in $ B.W.I.	331	320	314	308
Export Agriculture to total G.D.P. in $ B.W.I.	3618.3	5013.6	5991.0	4500.0
Percentage share of export agriculture in the G.D.P.	17.9	17.5	21.7	17.5

Source: B. Persaud, An Abstract of West Indian Banana Statistics, Institute of Social and Economic Research, University of the West Indies, Barbados, October 1966, p. 37.

It should also be noted that in many of the Windward and Leeward Islands, there is a tendency towards dependence on a single crop (Table XXI). In Antigua this most important crop is sugar; in Montserrat cotton is the leading export commodity and in Grenada, cocoa accounts for a higher percentage of the domestic exports than any other crop. St. Vincent, St. Lucia and Dominica all show a heavy dependence on banana exports which account for

most of the domestic exports. The economic stability of these islands today, as in the past, is closely related to their dependence on export agriculture, much of which is supplied by a single crop.

TABLE XXI - MAJOR EXPORTS AS A PERCENTAGE OF TOTAL DOMESTIC EXPORTS, 1963

	Dominica	Grenada	St.Lucia	St. Vincent	Antigua	Montserrat
Arrowroot				27.2		
Bay oil	2.1					
Bananas	69.9	22.2	78.5	50.4		6.6
Citrus	2.1					
Cocoa	2.5	45.5	3.6			
Copra	6.5		7.1	13.8		
Coconut oil			7.9			
Cotton		0.7		0.7	3.7	66.6
Mace		9.8		0.5		
Molasses					1.7	
Nutmegs		19.3		1.5		
Lime juice	9.3					4.5
Lime oil	4.6	0.4				
Sugar					92.3	
Sweet potato				2.1		
Vegetables						10.0
Total	97.0	97.8	97.1	96.2	97.7	87.7

Source: Great Britain, Colonial Office Reports, H.M.S.O., London, 1965.

Dominica is no exception to the pattern of dependence on export agriculture which is found in the neighbouring islands and the importance of this sector in the economy must not be underestimated. As can be seen from Table XXII the total Gross Domestic Product continued to grow during the period 1961 to 1964 and the percentage contributed by export agriculture increased. It is assumed that this growth in the G.D.P. of Dominica represents "real" increase in productivity and not just a "money" increase. Although figures are not available to show if there has been an increase in price levels, an abstract of statistics for the Lesser Antilles notes that the "GDP of Dominica and St. Lucia have grown conspicuously with in-

TABLE XXII - PERCENTAGE CONTRIBUTED BY EACH SECTOR TO THE TOTAL G.D.P.,1961-1964

	1961	1962	1963	1964
Total G.D.P. in B.W.I. $ '000	3983.2	3618.3	4619.2	5511.8
Export Agriculture	18	18	22	23
Other Agriculture	14	14	14	13
Fishing and Livestock	3	4	4	3
Construction and Engineering	9	9	6	6
Manufacturing and Mining	7	9	6	6
Distribution and Commerce	12	5	6	7
Transport	3	3	3	4
Services and Professions	6	6	5	5
Finance	2	3	2	2
Rent of Dwelling	11	13	13	12
Government	15	16	16	14
Total	100	100	100	100

Source: E. Bartell, National Income Statistics, Dominica 1961-1964, University of the West Indies Institute of Social and Economic Research, Statistical Series No. 2, Barbados, 1965, p. 19.

creases in banana production."[1] Thus, the increase is real and not due solely to inflation. The percentage contributed by agriculture to the total G.D.P. increased from 18 per cent in 1961 to 23 per cent in 1964 in the sector described as export agriculture; although the sector described as other agriculture showed no percentage increase, there was an actual increase from B.W.I. $2,917,000 in 1961 to $3,088,600 in 1964. These figures simply indicate that the value of agricultural production is increasing but the dependence of the economy on agricultural production is also increasing.

The importance of agriculture in the economy is further emphasized when other sectors of the economy are examined. The sector described as Manufacturing and Mining consists largely of the processing of agricultural

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[1] Institute of Social and Economic Research, An Abstract of Statistics of the Leeward Islands, Windward Islands and Barbados, University of the West Indies, Barbados, 1966, p. 35.

produce for export. The only mining activity is the extraction of pumice which began in 1964. The most important manufacturing activities are the processing of limes, copra and bay oil as well as the manufacture of hand-made straw goods which are also exported. The remainder of the manufacturing sector is made up of the production of bread, rum, soft drinks and cigarettes, for the domestic market.[2]

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[2]E. Bartell, National Income Statistics, Dominica 1961-1964, University of the West Indies, Institute of Social and Economic Research, Statistical Series No. 2, Barbados, 1965, p. 8.

APPENDIX B

QUESTIONNAIRE

<u>CONFIDENTIAL</u>

Map location number.

Total acreage of the estate?

Crops grown in order of importance of cash sale? (1) (2) (3) (4) (5)

How many acres are in ______________ ______________ ______________

______________ ______________

Which crops are grown for export?

What subsistence crops (if any) are grown?

What is the acreage for each crop?

What livestock (if any) are kept on the plantation?

How many acres are in pasture?

How many acres, formerly in production, are now vacant?

What diseases/pests (if any) have affected production in the last five years?

How many acres have been affected?

How many acres are occupied by tenants?

What is the source of your labour supply?

How much fertilizer was used last year?

What is the average weight per stem of bananas?

Where are the ______________ sold? How many miles from this plantation? ______________

______________ ______________

______________ ______________

______________ ______________

______________ ______________

What volume (by weight or bulk) of ______________ are sold?

____

____

____

____

What price per unit volume is received for ______________

____

____

____

____

Who transports ______________ to the place of sale?

____

____

____

____

How are ______________ transported?

____

____

____

____

Plantation transport

What are the transport costs

(per unit volume) of ____________________ to market?

____

____

____

____

If unknown, what would you be willing to pay?

What are the handling costs to the grower?

Are there transport subsidies?

Hired transport

What are the volume rates per mile for ______________

____

____

____

____

Is this rate uniform throughout the island?

If not, why does it change?

APPENDIX C

SOILS

Hardy's work on the classification of the volcanic soils of the Lesser Antilles[1] is still used as the basis for the description of soils in these islands.[2] Soils were grouped:

I Azonal Soils: 1) Lithosols 2) Alluvial Soils

Lithosols are immaturely developed soils of scarcely weathered rock fragments. Organic weathering at the surface may produce some fine sandy material which overlies the rock fragments. These soils are generally well drained except when a thin crust of soil forms on the bedrock, and then drainage becomes impeded. Because of the immaturity of the soil it is of limited agricultural value.

Alluvial soils formed in the flat valley bottoms and estuaries of the larger rivers are derived from a wide variety of other volcanic soils. Particle size is small, and the soil is finely textured and permeable. In a few cases, however, due to lack of slope impeded drainage becomes a problem.

II Intrazonal Soils:

A. Calomorphic soils: 3) "Yellow-Earth" soils, 4) "Brown-Earth" soils

B. Hydromorphic soils: 5) "Terras" soil, 6) "Shoal" soil, 7) "Terre-grasse" soil

"Yellow-Earth" soils are derived from the finer materials of volcanic ash and cinder. Particle size is fine and granular and the profile shows an A-B horizon of up to 3 feet thick, made up of a humic sandy loam. These

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[1] F. Hardy and G. Rodrigues, "Soil genesis from fragmental volcanic rocks in the Lesser Antilles," Proceedings of the Soil Science Society of America, Vol.6, 1941, pp. 47-51; F. Hardy and J.S. Beard, Soil Formation in the British Caribbean Islands (P.R. Soil Conference, 1950).

[2] Regional Research Centre of the British Caribbean, Soil and Land-use Surveys No. 21, Dominica, 1967, p. 20.

soils drain freely and because of their youth still retain much of the mineral content. They are known as highly fertile soils.

"Brown-Earth" soils are similar in age and formation to the "Yellow-Earth" soils, but have been derived from coarser parent material *viz.* agglomerates and gravels. Particle size tends to be larger than the "Yellow-Earth" soil and the soil is gritty in texture with a higher stony content. Drainage is generally good and agricultural potential is slightly lower than the "Yellow-Earth" soils because of the stoniness.

The "Terras" soils are very similar to the "Yellow-Earth" soil except that it is more developed with considerable leaching. It tends to be intermediate in age rather than youthful, but retains a loamy texture in its topsoil. A strong B horizon develops, however, and gives rise to impeded drainage. Because of the leaching this soil is not as fertile as the "Yellow-Earth" soil.

"Shoal" soils are much more maturely developed than any of the preceding soils described. The B horizon is more strongly cemented than that of the "Terras" soil group and impeded drainage is a characteristic feature. These soils tend to be dark brownish-green in colour and waxy, slippery and poorly aerated when wet. Like the "Terras" soils, they become very hard, forming cracks on the surface when they dry out and are difficult to cultivate.

"Terre grasse" soils are formed from kaolinic tuffs and form a heavy clay similar to "Shoal" soils. They are not common in Dominica.

III Zonal Soils: 8) "Red-Earth" soils

"Red-Earth" soils are maturely developed and are the highland equivalent of the "Shoal" soils found in lower land. Particle size is small and although highly leached, they show no horizon formation. The top soil of dark-brown humic material grades imperceptibly into the bright reddish clay

underneath. Because of small particle size and heavy rainfall the soil is often compacted, poorly aerated. It is generally regarded as being infertile.

APPENDIX D

CROP COMBINATIONS

The identification of crop combinations for the estates surveyed in Dominica was based on the method developed by Weaver in his study of the American Middle West.[1] The income for each crop was determined as a percentage of the total gross income for each estate. In order to determine the correct crop-combination for each estate, the percentage incomes for the major crops were measured against the theoretical curve proposed by Weaver. The curve is determined thus:

monoculture	=	100.00% of the total income from one crop
2-crop combination	=	50.00% for each of two crops
3-crop combination	=	33.33% for each of three crops
4-crop combination	=	25.00% for each of four crops
5-crop combination	=	20.00% for each of five crops

The percentage income from each crop on all estates was measured against this theoretical curve. However, "Since only relative rank of amount of deviation among the several possible combinations was desired and not the magnitude of deviation, the square root was not extracted in accordance with the standard deviation formula."[2] The formula for the variant was therefore used:

$$\sigma = \frac{\Sigma d^2}{n}$$

where "d" is the difference between the actual percentage income and the appropriate percentage in the theoretical curve, and "n" is the number of crops in a given combination.

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[1]J.C. Weaver, "Crop-combinations Regions in the Middle West," <u>The Geographical Review</u>, Volume 44, No. 2, 1954, pp. 175-200.

[2]<u>Ibid</u>., p. 180.

The crop combination which showed the least deviation from the theoretical curve was thus assumed to be the most appropriate. For example, Estate A had the following percentage incomes from crops: bananas 47 per cent, oranges 31 per cent, coconuts 10 per cent, grapefruit 8 per cent, limes 4 per cent. Each crop is referred to by the initial letter as in Map 8.

TABLE XXIII - CROP COMBINATIONS

	Mono-culture	2 crop		3 crop			4 crop				5 crop				
	B	B	O	B	O	C	B	O	C	G	B	O	G	C	L
% income	47	47	31	47	31	10	47	31	10	8	47	31	10	8	4
% theoretical base curve	100	50	50	33	33	33	25	25	25	25	20	20	20	20	40
Difference	53	3	19	14	2	23	22	6	15	17	27	11	10	12	16
Difference squared	2809	9	361	215	6	544	484	36	225	289	729	121	100	144	256
Sum of squared differences	2809	370		765			1034				1350				
Sum divided by number of crops	2809	185		255			259				270				

Table 23 shows that for Estate A the deviation of the actual percentages from the theoretical curve is lowest for a two-crop combination. Hence, Estate A would be regarded as a two-crop combination estate and shown on Map 8 as B O. Moreover, if oranges had contributed 47 per cent and bananas only 31 per cent of the total gross income, the estate would still have been represented by B O since only the crop-combination was sought and not the relative importance of individual crops. The order in which the initial letters were arranged is not related to their order of importance but accordingly as they appeared in the following order: bananas, limes, grapefruit, oranges, coconuts and bay leaf, and as shown on Map 8.